

HAWAII ADMINISTRATIVE RULES

TITLE 12

DEPARTMENT OF LABOR AND INDUSTRIAL RELATIONS

SUBTITLE 8

DIVISION OF OCCUPATIONAL SAFETY AND HEALTH

PART 8

HEALTH STANDARDS

CHAPTER 202

TOXIC MATERIALS AND HARMFUL PHYSICAL AGENTS

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Historical Note: Chapter 202 of title 12 is based upon chapter 304 of the Hawaii Occupational Safety and Health Standards, Rules and Regulations. [Eff. 7/11/74; am 6/7/76; am 12/30/76; am 1/9/78; am 8/11/78; am 8/23/79; R 7/12/82]

§12-202-1 General requirements. (a) The purpose of this chapter is to prescribe minimum standards for the maintenance of employee health and safety in workplaces with an environment that contains toxic materials or harmful physical agents. Specific standards for particular toxic materials or harmful physical agents are contained in section 12-202-13 and subsequent sections. The specific standards take precedence over the more general requirements.

- (b) Caution information in the form of signs, notices, etc., shall be provided to employees at each location where there is exposure to toxic materials or harmful physical agents. Labels shall be affixed to all toxic materials or harmful physical agents, or their containers, warning of their potential danger.
 - (1) Radiation areas under the jurisdiction of the Nuclear Regulatory Commission (NRC) shall be posted as required by the NRC. Areas in which there may be exposure to biological hazards shall be posted.
 - (2) In other areas, when there is no exposure except when working with the toxic materials or harmful physical agents, caution signs shall be posted to indicate the potential hazards of any activities, processes, or materials. For example, signs such as "Hazardous Materials, Do Not Disturb" or "Caution: Keep Flames Away," or "In Case of Fire, use Sand," etc.
- (c) Employers shall post prominently or make available to affected employees information regarding hazards posed by toxic materials or harmful physical agents in the employer's workplace. The information shall include suitable precautions, relevant symptoms, emergency treatment in case of overexposure, and, where appropriate, the availability of medical examination at no cost to the employee.
- (d) Wherever the use of personal protective equipment is deemed appropriate or necessitated by exposure to toxic materials or harmful physical agents, employers shall provide this equipment and it shall be used and maintained in a sanitary and reliable condition.
- (e) All employers shall measure, monitor, and record employee exposure to toxic materials or harmful physical agents. The measurement shall determine if any employee may be exposed to concentrations of the toxic materials or harmful physical agents at or above the permissible exposure limit. The determination shall be made each time there is a change in production, process, or control measures which could result in an increase in concentrations of these materials or agents. A written record of the determination shall be made and shall contain at least:
 - (1) Any information, observations, or calculations that may indicate employee exposure to toxic or potentially toxic materials or harmful physical agents;
 - (2) Any measurements taken;
 - (3) Any employee complaints of symptoms that may be attributable to exposure to toxic or potentially toxic materials or harmful physical agents;
 - (4) Date of determination, work being performed at the time, location within work site, name, and social security number of each employee considered; and
 - (5) Any other information that may be relevant to employee exposure.
- (f) When medical examinations are appropriate for adequate employee protection, the employer shall, at the employer's cost, provide examinations to best determine the effect of toxic material or harmful physical agents on the health of employees. [Eff. 7/12/82; am 6/16/84; am 3/22/91] (Auth: HRS §396-4) (Imp: HRS §396-4)

§12-202-2 Definitions. As used in this chapter:

"Access" means the right and opportunity to examine and copy.

"Air contaminant" means the equivalent of the terms "material" and "substance" for this chapter.

"Analysis using exposure or medical records" means any compilation of data, or any research, or statistical or other studies based at least in part on information collected from individual employee exposure or medical records or information collected from health insurance claims records, provided that either the analysis has been reported to the employer or no further work is currently being done by the person responsible for preparing the analysis.

"ANSI" means the American National Standards Institute.

"ANSI Z9.2" means ANSI Z9.2-1979, Fundamentals Governing the Design and Operation of Local Exhaust Systems.

"ANSI Z88.2" means ANSI Z88.2-1984, Practices for Respiratory Protection.

"Coal tar pitch volatiles" mean, as used in table 202-1, the fused polycyclic hydrocarbons which volatilize from the distillation residues of coal, petroleum (excluding asphalt, CAS 8052-42-4 and CAS 64742-93-4), wood, and other organic matter.

"Designated representative," means any individual or organization to whom an employee gives written authorization to exercise a right of access. For the purpose of access to employee exposure records and analyses using exposure or medical records, a recognized or certified collective-bargaining agent shall be treated automatically as a designated representative without regard to written employee authorization.

"Employee" means a current employee, a former employee, or an employee being assigned or transferred to work where there will be exposure to toxic materials or harmful physical agents.

"Employee exposure record" means a record containing any of the following kinds of information:

- (1) Environmental (workplace) monitoring or measuring of a toxic substance or a harmful physical agent, including personal, area, grab, or wipe sampling, or any other form of sampling, as well as related collection and analytical methodologies, calculations, and other background data relevant to interpretation of the results obtained;
- (2) Biological monitoring results which directly assess the absorption of a substance or agent by body systems (e.g., the level of a chemical in the blood, urine, breath, hair, fingernails, etc.) but not including results which assess the biological effect of a substance or agent or which assess an employee's use of alcohol or drugs;
- (3) Material safety-data sheets; and
- (4) A chemical inventory or any other record which reveals where and when used and the identity (e.g., chemical, common, or trade name) of a toxic substance or harmful physical agent.

"Employee medical record" means a record concerning the health status of an employee, which is made or maintained by a physician or nurse, or any other health care personnel or technician, including:

- (1) Medical and employment questionnaires or histories (including job description and occupational exposures);
- (2) The results of medical examinations (pre-employment, pre-assignment, periodic, or episodic) and laboratory tests (including chest and other X-ray examinations taken for the purposes of establishing a base-line or detecting occupational illness, and all biological monitoring not defined as an "employee exposure record");
- (3) Medical opinions, diagnoses, progress notes, and recommendations;
- (4) Descriptions of treatments and prescriptions;
- (5) First-aid records; and
- (6) Employee medical complaints; but does not include medical information in the form of:
 - (A) Physical specimens (e.g., blood or urine samples) which are routinely discarded as a part of normal medical practice; or
 - (B) Records concerning health insurance claims if maintained separately from the employer's medical program and its records, and not accessible to the employer by employee name or other direct personal identifier (e.g., social security number, payroll number, etc.); or
 - (C) Records created solely in preparation for litigation which are privileged from discovery under the applicable rules of procedure

- or evidence; or
- (D) Records concerning voluntary employee assistance programs (alcohol, drug abuse, or personal counseling programs) if maintained separately from the employer's medical program and its records.

"Employer" means a current employer, a former employer, or a successor employer.

"Excursion factor" means the magnitude of the permissible excursion above the PEL-TWA for those substances not preceded by a "C" in table 202-1 and not found in table 202-2.

"Exposure" or "exposed" means that an employee is subjected to a toxic material or harmful physical agent in the course of employment through any route of entry, such as inhalation, ingestion, skin contact, or absorption, and includes past exposure and potential exposure.

"Health professional" means a physician, occupational health nurse, industrial hygienist, toxicologist, or epidemiologist, providing medical or other occupational health services to exposed employees.

"Material" see "Air contaminant".

"Permissible Exposure Limit (PEL)" means the airborne concentrations of substances to which it is believed that nearly all workers may be exposed with no adverse effect.

"Permissible Exposure Limit-Ceiling (PEL-C)" means the concentration that shall not be exceeded even instantaneously. The PEL-C is the employee's exposure, which shall not be exceeded during any part of the workday. If instantaneous monitoring is not feasible, then the ceiling shall be assessed as a 15-minute time weighted average exposure, which shall not be exceeded at any time over a working day.

"Permissible Exposure Limit-Short Term Exposure Level (PEL-STEL)" means the employee's 15-minute time weighted average exposure, which shall not be exceeded at any time during a workday unless another time limit is specified in a parenthetical notation below the limit. If another time period is specified, the time weighted average exposure over that time limit shall not be exceeded at any time during the workday.

"Permissible Exposure Limit-Time Weighted Average (PEL-TWA)" means the employee's average airborne exposure, which shall not be exceeded in any 7- to 8-hour work shift of a 40-hour workweek.

"Record" means any item, collection, or grouping of information regardless of the form or process by which it is maintained (e.g., paper document, microfiche, microfilm, X-ray film, or automated data processing).

"SIC" means the Standard Industrial Classification.

"Specific chemical identity" means the chemical name, Chemical Abstracts Service (CAS) Registry Number, or any other information that reveals the precise chemical designation of the substance.

"Specific written consent" means a written authorization containing:

- (1) The name and signature of the employee authorizing the release of medical information;
- (2) The date of the written authorization;
- (3) The name of the individual or organization that is authorized to release the medical information;
- (4) The name of the designated representative (individual or organization) that is authorized to receive the released information;
- (5) A general description of the medical information that is authorized to be released;
- (6) A general description of the purpose for the release of the medical information; and
- (7) A date or condition upon which the written authorization will expire (if less than one year); but

A written authorization does not authorize the release of medical information not in existence on the date of written authorization, unless the release of future information is expressly authorized, and does not operate for more than one year from the date of written authorization. A written authorization may be revoked in writing prospectively at any time.

"Substance" see "Air contaminant".

"Toxic material or harmful physical agent" means any chemical substance, biological agent (bacteria, virus, fungus, etc.), or physical stress (noise, heat, cold, vibration, repetitive motion, ionizing and non-ionizing radiation, hypo- or hyperbaric pressure, etc.) which:

- (1) Is listed in the latest printed edition of the National Institute

for Occupational Safety and Health (NIOSH) Registry of Toxic Effects of Chemical Substances (RTECS); or

(2) Has yielded positive evidence of an acute or chronic health hazard in testing conducted by, or known to, the employer; or

(3) Is the subject of a material safety-data sheet kept by or known to the employer indicating that the material may pose a hazard to human health.

"Trade secret" means any confidential formula, pattern, process, device, or information or compilation of information that is used in an employer's business and that gives the employer an opportunity to obtain an advantage over competitors who do not know or use it. [Eff. 7/12/82; am 5/28/83; am 6/16/84; am 8/5/88; am 3/22/91] (Auth: HRS §396-3) (Imp: HRS §396-3)

§12-202-3.1 Access to employee exposure and medical records.

- (a) **Incorporation of federal standard.** Title 29, Code of Federal Regulations, section 1910.1020, entitled "Access to employee exposure and medical records", published by the Office of the Federal Register, National Archives and Records Administration, on September 29, 1988; and the amendments published on December 13, 1988; June 7, 1989; June 28, 1990; March 7, 1996, and redesignated June 20, 1996, are made a part of this section, except as provided in subsection (b).
- (b) **Definitions.** As used in 29 CFR section 1910.1020 and applied to this section:
 "§1913.10" means chapter 12-55. [Eff 12/29/00] (Auth: HRS §396-4) (Imp: HRS §396-4)

Historical note: §12-202-3.1 is based substantially upon section 12-202-3. [Eff 7/12/82; am 6/16/84; am 3/22/91; R 12/29/00]

§1910.1020 Access to employee exposure and medical records.

- (a) **Purpose.** The purpose of this section is to provide employees and their designated representatives a right of access to relevant exposure and medical records; and to provide representatives of the Assistant Secretary a right of access to these records in order to fulfill responsibilities under the Occupational Safety and Health Act. Access by employees, their representatives, and the Assistant Secretary is necessary to yield both direct and indirect improvements in the detection, treatment, and prevention of occupational disease. Each employer is responsible for assuring compliance with this section, but the activities involved in complying with the access to medical records provisions can be carried out, on behalf of the employer, by the physician or other health care personnel in charge of employee medical records. Except as expressly provided, nothing in this section is intended to affect existing legal and ethical obligations concerning the maintenance and confidentiality of employee medical information, the duty to disclose information to a patient/employee or any other aspect of the medical-care relationship, or affect existing legal obligations concerning the protection of trade secret information.
- (b) **Scope and application.**
 - (1) This section applies to each general industry, maritime, and construction employer, who makes, maintains, contracts for, or has access to employee exposure or medical records, or analyses thereof, pertaining to employees exposed to toxic substances or harmful physical agents.
 - (2) This section applies to all employee exposure and medical records, and analyses thereof, of such employees, whether or not the records are mandated by specific occupational safety and health standards.
 - (3) This section applies to all employee exposure and medical records, and analyses thereof, made or maintained in any manner, including on an in-house or contractual (e.g., fee-for-service) basis. Each employer shall assure that the preservation and access requirements of this section are complied with regardless of the manner in which records are made or maintained.
- (c) **Definitions.**
 - (1) **Access** means the right and opportunity to examine and copy.
 - (2) **Analysis using exposure or medical records** means any compilation of data or any statistical study based at least in part on information collected from individual employee exposure or medical records or information collected from health insurance claims records, provided that either the analysis has been reported to the employer or no further work is

- currently being done by the person responsible for preparing the analysis.
- (3) **Designated representative** means any individual or organization to whom an employee gives written authorization to exercise a right of access. For the purposes of access to employee exposure records and analyses using exposure or medical records, a recognized or certified collective bargaining agent shall be treated automatically as a designated representative without regard to written employee authorization.
 - (4) **Employee** means a current employee, a former employee, or an employee being assigned or transferred to work where there will be exposure to toxic substances or harmful physical agents. In the case of a deceased or legally incapacitated employee, the employee's legal representative may directly exercise all the employee's rights under this section.
 - (5) **Employee exposure record** means a record containing any of the following kinds of information:
 - (i) Environmental (workplace) monitoring or measuring of a toxic substance or harmful physical agent, including personal, area, grab, wipe, or other form of sampling, as well as related collection and analytical methodologies, calculations, and other background data relevant to interpretation of the results obtained;
 - (ii) Biological monitoring results which directly assess the absorption of a toxic substance or harmful physical agent by body systems (e.g., the level of a chemical in the blood, urine, breath, hair, fingernails, etc.) but not including results which assess the biological effect of a substance or agent or which assess an employee's use of alcohol or drugs;
 - (iii) Material safety data sheets indicating that the material may pose a hazard to human health; or
 - (iv) In the absence of the above, a chemical inventory or any other record which reveals where and when used and the identity (e.g., chemical, common, or trade name) of a toxic substance or harmful physical agent.
 - (6) (i) **Employee medical record** means a record concerning the health status of an employee which is made or maintained by a physician, nurse, or other health care personnel, or technician, including:
 - (A) Medical and employment questionnaires or histories (including job description and occupational exposures),
 - (B) The results of medical examinations (pre-employment, pre-assignment, periodic, or episodic) and laboratory tests (including chest and other X-ray examinations taken for the purpose of establishing a base-line or detecting occupational illnesses and all biological monitoring not defined as an "employee exposure record"),
 - (C) Medical opinions, diagnoses, progress notes, and recommendations,
 - (D) First aid records,
 - (E) Descriptions of treatments and prescriptions, and
 - (F) Employee medical complaints.
 (ii) "Employee medical record" does not include medical information in the form of:
 - (A) Physical specimens (e.g., blood or urine samples) which are routinely discarded as a part of normal medical practice; or
 - (B) Records concerning health insurance claims if maintained separately from the employer's medical program and its records, and not accessible to the employer by employee name or other direct personal identifier (e.g., social security number, payroll number, etc.), or
 - (C) Records created solely in preparation for litigation which are privileged from discovery under the applicable rules of procedure or evidence; or
 - (D) Records concerning voluntary employee assistance programs (alcohol, drug abuse, or personal counseling programs) if maintained separately from the employer's medical program and its records.
 - (7) **Employer** means a current employer, a former employer, or a successor employer.
 - (8) **Exposure or exposed** means that an employee is subjected to a toxic substance or harmful physical agent in the course of employment through any route of entry (inhalation, ingestion, skin contact or absorption, etc.), and includes past exposure and potential (e.g., accidental or possible) exposure, but does not include situations where the employer can demonstrate that the toxic substance or harmful physical agent is not used, handled, stored, generated, or present in the workplace in any manner different from typical non-occupational situations.
 - (9) **Health Professional** means a physician, occupational health nurse, industrial hygienist, toxicologist, or epidemiologist, providing medical or other occupational health services to

- exposed employees.
- (10) **Record** means any item, collection, or grouping of information regardless of the form or process by which it is maintained (e.g., paper document, microfiche, microfilm, X-ray film, or automated data processing).
 - (11) **Specific chemical identity** means a chemical name, Chemical Abstracts Service (CAS) Registry Number, or any other information that reveals the precise chemical designation of the substance.
 - (12) (i) **Specific written consent** means a written authorization containing the following:
 - (A) The name and signature of the employee authorizing the release of medical information,
 - (B) The date of the written authorization,
 - (C) The name of the individual or organization that is authorized to release the medical information,
 - (D) The name of the designated representative (individual or organization) that is authorized to receive the released information,
 - (E) A general description of the medical information that is authorized to be released,
 - (F) A general description of the purpose for the release of the medical information, and
 - (G) A date or condition upon which the written authorization will expire (if less than one year).
 - (ii) A written authorization does not operate to authorize the release of medical information not in existence on the date of written authorization, unless the release of future information is expressly authorized, and does not operate for more than one year from the date of written authorization.
 - (iii) A written authorization may be revoked in writing prospectively at any time.
 - (13) **Toxic substance or harmful physical agent** means any chemical substance, biological agent (bacteria, virus, fungus, etc.), or physical stress (noise, heat, cold, vibration, repetitive motion, ionizing and non-ionizing radiation, hypo- or hyperbaric pressure, etc.) which:
 - (i) Is listed in the latest printed edition of the National Institute for Occupational Safety and Health (NIOSH) Registry of Toxic Effects of Chemical Substances (RTECS), which is incorporated by reference as specified in §1910.6; or
 - (ii) Has yielded positive evidence of an acute or chronic health hazard in testing conducted by, or known to, the employer; or
 - (iii) Is the subject of a material safety data sheet kept by or known to the employer indicating that the material may pose a hazard to human health.
 - (14) **Trade secret** means any confidential formula, pattern, process, device, or information or compilation of information that is used in an employer's business and that gives the employer an opportunity to obtain an advantage over competitors who do not know or use it.
- (d) **Preservation of records.**
- (1) Unless a specific occupational safety and health standard provides a different period of time, each employer shall assure the preservation and retention of records as follows:
 - (i) Employee medical records. The medical record for each employee shall be preserved and maintained for at least the duration of employment plus thirty (30) years, except that the following types of records need not be retained for any specified period:
 - (A) Health insurance claims records maintained separately from the employer's medical program and its records,
 - (B) First aid records (not including medical histories) of one-time treatment and subsequent observation of minor scratches, cuts, burns, splinters, and the like which do not involve medical treatment, loss of consciousness, restriction of work or motion, or transfer to another job, if made on-site by a non-physician and if maintained separately from the employer's medical program and its records, and
 - (C) The medical records of employees who have worked for less than (1) year for the employer need not be retained beyond the term of employment if they are provided to the employee upon the termination of employment.
 - (ii) Employee exposure records. Each employee exposure record shall be preserved and maintained for at least thirty (30) years, except that:
 - (A) Background data to environmental (workplace) monitoring or measuring, such as laboratory reports and worksheets, need only be retained for one (1) year so long as the sampling results, the collection methodology (sampling plan), a description of the analytical and mathematical methods used, and a summary of other background data relevant to interpretation of the results obtained, are retained for at least thirty

- (30) years; and
- (B) Material safety data sheets and paragraph (c)(5)(iv) records concerning the identity of a substance or agent need not be retained for any specified period as long as some record of the identity (chemical name if known) of the substance or agent, where it was used, and when it was used is retained for at least thirty (30) years¹; and
- (C) Biological monitoring results designated as exposure records by specific occupational safety and health standards shall be preserved and maintained as required by the specific standard.
- (iii) Analyses using exposure or medical records. Each analysis using exposure or medical records shall be preserved and maintained for at least thirty (30) years.
- (2) Nothing in this section is intended to mandate the form, manner, or process by which an employer preserves a record so long as the information contained in the record is preserved and retrievable, except that chest X-ray films shall be preserved in their original state.
- (e) Access to records.
 - (1) General.
 - (i) Whenever an employee or designated representative requests access to a record, the employer shall assure that access is provided in a reasonable time, place, and manner. If the employer cannot reasonably provide access to the record within fifteen (15) working days, the employer shall within the fifteen (15) working days apprise the employee or designated representative requesting the record of the reason for the delay and the earliest date when the record can be made available.
 - (ii) The employer may require of the requester only such information as should be readily known to the requester and which may be necessary to locate or identify the records being requested (e.g. dates and locations where the employee worked during the time period in question).
 - (iii) Whenever an employee or designated representative requests a copy of a record, the employer shall assure that either:
 - (A) A copy of the record is provided without cost to the employee or representative,
 - (B) The necessary mechanical copying facilities (e.g., photocopying) are made available without cost to the employee or representative for copying the record, or
 - (C) The record is loaned to the employee or representative for a reasonable time to enable a copy to be made.
 - (iv) In the case of an original X-ray, the employer may restrict access to on-site examination or make other suitable arrangements for the temporary loan of the X-ray.
 - (v) Whenever a record has been previously provided without cost to an employee or designated representative, the employer may charge reasonable, non-discriminatory administrative costs (i.e., search and copying expenses but not including overhead expenses) for a request by the employee or designated representative for additional copies of the record, except that
 - (A) An employer shall not charge for an initial request for a copy of new information that has been added to a record which was previously provided; and
 - (B) An employer shall not charge for an initial request by a recognized or certified collective bargaining agent for a copy of an employee exposure record or an analysis using exposure or medical records.
 - (vi) Nothing in this section is intended to preclude employees and collective bargaining agents from collectively bargaining to obtain access to information in addition to that available under this section.
 - (2)¹ Employee and designated representative access.
 - (i) Employee exposure records.
 - (A) Except as limited by paragraph (f) of this section, each employer shall, upon request, assure the access to each employee and designated representative to employee exposure records relevant to the employee. For the purpose of this section, an exposure record relevant to the employee consists of:

¹ Material safety data sheets must be kept for those chemicals currently in use that are effected by the Hazard Communication Standard in accordance with 29 CFR 1910.1200(g).

- (1) A record that measures or monitors the amount of a toxic substance or harmful physical agent to which the employee is or has been exposed;
 - (2) In the absence of such directly relevant records, such records of other employees with past or present job duties or working conditions related to or similar to those of the employee to the extent necessary to reasonably indicate the amount and nature of the toxic substances or harmful physical agents to which the employee is or has been subjected, and
 - (3) Exposure records to the extent necessary to reasonably indicate the amount and nature of the toxic substances or harmful physical agents at workplaces or under working conditions to which the employee is being assigned or transferred.
- (B) Requests by designated representatives for unconsented access to employee exposure records shall be in writing and shall specify with reasonable particularity:
 - (1) The record requested to be disclosed; and
 - (2) The occupational health need for gaining access to these records.
- (ii) Employee medical records.
 - (A) Each employer shall, upon request, assure the access of each employee-to-employee medical records of which the employee is the subject, except as provided in paragraph (e)(2)(ii)(D) of this section.
 - (B) Each employer shall, upon request, assure the access of each designated representative to the employee medical records of any employee who has given the designated representative specific written consent. Appendix A to this section contains a sample form that may be used to establish specific written consent for access to employee medical records.
 - (C) Whenever access to employee medical records is requested, a physician representing the employer may recommend that the employee or designated representative:
 - (1) Consult with the physician for the purposes of reviewing and discussing the records requested,
 - (2) Accept a summary of material facts and opinions in lieu of the records requested, or
 - (3) Accept release of the requested records only to a physician or other designated representative.
 - (D) Whenever an employee requests access to his or her employee medical records, and a physician representing the employer believes that direct employee access to information contained in the records regarding a specific diagnosis of a terminal illness or a psychiatric condition could be detrimental to the employee's health, the employer may inform the employee that access will only be provided to a designated representative of the employee having specific written consent, and deny the employee's request for direct access to this information only. Where a designated representative with specific written consent requests access to information so withheld, the employer shall assure the access of the designated representative to this information, even when it is known that the designated representative will give the information to the employee.
 - (E) A physician, nurse, or other responsible health care personnel maintaining employee medical records may delete from requested medical records the identity of a family member, personal friend, or fellow employee who has provided confidential information concerning an employee's health status.
- (iii) Analyses using exposure or medical records.
 - (A) Each employer shall, upon request, assure the access of each employee and designated representative to each analysis using exposure or medical records concerning the employee's working conditions or workplace.
 - (B) Whenever access is requested to an analysis which reports the contents of employee medical records by either direct identifier (name, address, social security number, payroll number, etc.) or by information which could reasonably be used under the circumstances indirectly to identify specific employees (exact age, height, weight, race, sex, date of initial employment, job title, etc.), the employer shall assure that personal identifiers are removed before access is provided. If the employer can demonstrate that removal of personal identifiers from an analysis is

not feasible, access to the personally identifiable portions of the analysis need not be provided.

- (3) OSHA access.
 - (i) Each employer shall, upon request, and without derogation of any rights under the Constitution or the Occupational Safety and Health Act of 1970, 29 U.S.C. 651 "et seq.," that the employer chooses to exercise, assure the prompt access of representatives of the Assistant Secretary of Labor for Occupational Safety and Health to employee exposure and medical records and to analyses using exposure or medical records. Rules of agency practice and procedure governing OSHA access to employee medical records are contained in 29 CFR 1913.10.
 - (ii) Whenever OSHA seeks access to personally identifiable employee medical information by presenting to the employer a written access order pursuant to 29 CFR 1913.10(d), the employer shall prominently post a copy of the written access order and its accompanying cover letter for at least fifteen (15) working days.
- (f) Trade secrets.
 - (1) Except as provided in paragraph (f)(2) of this section, nothing in this section precludes an employer from deleting from records requested by a health professional, employee, or designated representative any trade secret data which discloses manufacturing processes, or discloses the percentage of a chemical substance in mixture, as long as the health professional, employee, or designated representative is notified that information has been deleted. Whenever deletion of trade secret information substantially impairs evaluation of the place where or the time when exposure to a toxic substance or harmful physical agent occurred, the employer shall provide alternative information which is sufficient to permit the requesting party to identify where and when exposure occurred.
 - (2) The employer may withhold the specific chemical identity, including the chemical name and other specific identification of a toxic substance from a disclosable record provided that:
 - (i) The claim that the information withheld is a trade secret can be supported;
 - (ii) All other available information on the properties and effects of the toxic substance is disclosed;
 - (iii) The employer informs the requesting party that the specific chemical identity is being withheld as a trade secret; and
 - (iv) The specific chemical identity is made available to health professionals, employees and designated representatives in accordance with the specific applicable provisions of this paragraph.
 - (3) Where a treating physician or nurse determines that a medical emergency exists and the specific chemical identity of a toxic substance is necessary for emergency or first-aid treatment, the employer shall immediately disclose the specific chemical identity of a trade secret chemical to the treating physician or nurse, regardless of the existence of a written statement of need or a confidentiality agreement. The employer may require a written statement of need and confidentiality agreement, in accordance with the provisions of paragraphs (f)(4) and (f)(5), as soon as circumstances permit.
 - (4) In non-emergency situations, an employer shall, upon request, disclose a specific chemical identity, otherwise permitted to be withheld under paragraph (f)(2) of this section, to a health professional, employee, or designated representative if:
 - (i) The request is in writing;
 - (ii) The request describes with reasonable detail one or more of the following occupational health needs for the information:
 - (A) To assess the hazards of the chemicals to which employees will be exposed;
 - (B) To conduct or assess sampling of the workplace atmosphere to determine employee exposure levels;
 - (C) To conduct pre-assignment or periodic medical surveillance of exposed employees;
 - (D) To provide medical treatment to exposed employees;
 - (E) To select or assess appropriate personal protective equipment for exposed employees;
 - (F) To design or assess engineering controls or other protective measures for exposed employees; and
 - (G) To conduct studies to determine the health effects of exposure.
 - (iii) The request explains in detail why the disclosure of the specific chemical identity is essential and that, in lieu thereof, the disclosure of the following information would not

- enable the health professional, employee or designated representative to provide the occupational health services described in paragraph (f)(4)(ii) of this section;
- (A) The properties and effects of the chemical;
 - (B) Measures for controlling workers' exposure to the chemical;
 - (C) Methods of monitoring and analyzing worker exposure to the chemical; and
 - (D) Methods of diagnosing and treating harmful exposures to the chemical;
- (iv) The request includes a description of the procedures to be used to maintain the confidentiality of the disclosed information; and
 - (v) The health professional, employee, or designated representative and the employer or contractor of the services of the health professional or designated representative agree in a written confidentiality agreement that the health professional, employee or designated representative will not use the trade secret information for any purpose other than the health need(s) asserted and agree not to release the information under any circumstances other than to OSHA, as provided in paragraph (f)(9) of this section, except as authorized by the terms of the agreement or by the employer.
- (5) The confidentiality agreement authorized by paragraph (f)(4)(iv) of this section:
 - (i) May restrict the use of the information to the health purposes indicated in the written statement of need;
 - (ii) May provide for appropriate legal remedies in the event of a breach of the agreement, including stipulation of a reasonable pre-estimate of likely damages; and,
 - (iii) May not include requirements for the posting of a penalty bond.
 - (6) Nothing in this section is meant to preclude the parties from pursuing non-contractual remedies to the extent permitted by law.
 - (7) If the health professional, employee or designated representative receiving the trade secret information decides that there is a need to disclose it to OSHA, the employer who provided the information shall be informed by the health professional prior to, or at the same time as, such disclosure.
 - (8) If the employer denies a written request for disclosure of a specific chemical identity, the denial must:
 - (i) Be provided to the health professional, employee or designated representative within thirty days of the request;
 - (ii) Be in writing;
 - (iii) Include evidence to support the claim that the specific chemical identity is a trade secret;
 - (iv) State the specific reasons why the request is being denied; and,
 - (v) Explain in detail how alternative information may satisfy the specific medical or occupational health need without revealing the specific chemical identity.
 - (9) The health professional, employee, or designated representative whose request for information is denied under paragraph (f)(4) of this section may refer the request and the written denial of the request to OSHA for consideration.
 - (10) When a health professional, employee, or designated representative refers a denial to OSHA under paragraph (f)(9) of this section, OSHA shall consider the evidence to determine if:
 - (i) The employer has supported the claim that the specific chemical identity is a trade secret;
 - (ii) The health professional employee, or designated representative has supported the claim that there is a medical or occupational health need for the information; and
 - (iii) The health professional, employee or designated representative has demonstrated adequate means to protect the confidentiality.
 - (11) (i) If OSHA determines that the specific chemical identity requested under paragraph (f)(4) of this section is not a *bona fide* trade secret, or that it is a trade secret but the requesting health professional, employee or designated representatives has a legitimate medical or occupational health need for the information, has executed a written confidentiality agreement, and has shown adequate means for complying with the terms of such agreement, the employer will be subject to citation by OSHA.
 - (ii) If an employer demonstrates to OSHA that the execution of a confidentiality agreement would not provide sufficient protection against the potential harm from the unauthorized disclosure of a trade secret specific chemical identity, the Assistant Secretary may issue such orders or impose such additional limitations or conditions upon the disclosure of the requested chemical information as may be appropriate to assure that the occupational health needs are met without an undue risk of harm to the employer.
 - (12) Notwithstanding the existence of a trade secret claim, an employer shall, upon request, disclose to the Assistant Secretary any information that this section requires the employer to

- make available. Where there is a trade secret claim, such claim shall be made no later than at the time the information is provided to the Assistant Secretary so that suitable determinations of trade secret status can be made and the necessary protections can be implemented.
- (13) Nothing in this paragraph shall be construed as requiring the disclosure under any circumstances of process or percentage of mixture information that is a trade secret.
- (g) Employee information.**
- (1) Upon an employee's first entering into employment, and at least annually thereafter, each employer shall inform current employees covered by this section of the following:
 - (i) The existence, location, and availability of any records covered by this section;
 - (ii) The person responsible for maintaining and providing access to records; and
 - (iii) Each employee's rights of access to these records.
 - (2) Each employer shall keep a copy of this section and its appendices, and make copies readily available, upon request, to employees. The employer shall also distribute to current employees any informational materials concerning this section that are made available to the employer by the Assistant Secretary of Labor for Occupational Safety and Health.
- (h) Transfer of records.**
- (1) Whenever an employer is ceasing to do business, the employer shall transfer all records subject to this section to the successor employer. The successor employer shall receive and maintain these records.
 - (2) Whenever an employer is ceasing to do business and there is no successor employer to receive and maintain the records subject to this standard, the employer shall notify affected current employees of their rights of access to records at least three (3) months prior to the cessation of the employer's business.
 - (3) Whenever an employer either is ceasing to do business and there is no successor employer to receive and maintain the records, or intends to dispose of any records required to be preserved for at least thirty (30) years, the employer shall:
 - (i) Transfer the records to the Director of the National Institute for Occupational Safety and Health (NIOSH) if so required by a specific occupational safety and health standard; or
 - (ii) Notify the Director of NIOSH in writing of the impending disposal of records at least three (3) months prior to the disposal of the records.
 - (4) Where an employer regularly disposes of records required to be preserved for at least thirty (30) years, the employer may, with at least (3) months notice, notify the Director of NIOSH on an annual basis of the records intended to be disposed of in the coming year.
- (i) Appendices.** The information contained in appendices A and B to this section is not intended, by itself, to create any additional obligations not otherwise imposed by this section nor detract from any existing obligation.

**APPENDIX A TO §1910.1020—SAMPLE AUTHORIZATION LETTER FOR THE RELEASE
OF EMPLOYEE MEDICAL RECORD INFORMATION TO A DESIGNATED REPRESENTATIVE
(NON-MANDATORY)**

I, _____, (full name of worker/patient), hereby authorize
_____ (individual or organization holding the medical
records) to release to _____ (individual or organization authorized
to receive the medical information), the following medical information from my personal medical records:

(Describe generally the information desired to be released)

I give my permission for this medical information to be used for the following purpose:

_____,
but I do not give permission for any other use or re-disclosure of this information.

NOTE: Several extra lines are provided below so that you can place additional restrictions on this authorization letter if you want to. You may, however, leave these lines blank. On the other hand, you may want to (1) specify a particular expiration date for this letter (if less than one year); (2) describe medical information to be created in the future that you intend to be covered by this authorization letter; or (3) describe portions of the medical information in your records which you do not intend to be released as a result of this letter.)

Full name of Employee or Legal Representative

Signature of Employee or Legal Representative

Date of Signature

**APPENDIX B TO §1910.1020—AVAILABILITY OF NIOSH REGISTRY OF
TOXIC EFFECTS OF CHEMICAL SUBSTANCES (RTECS)
(NON-MANDATORY)**

The final regulation, 29 CFR 1910.1020, applies to all employee exposure and medical records, and analyses thereof, of employees exposed to toxic substances or harmful physical agents (paragraph (b)(2)). The term *toxic substance or harmful physical agent* is defined by paragraph (c)(13) to encompass chemical substances, biological agents, and physical stresses for which there is evidence of harmful health effects. The regulation uses the latest printed edition of the National Institute for Occupational Safety and Health (NIOSH) Registry of Toxic Effects of Chemical Substances (RTECS) as one of the chief sources of information as to whether evidence of harmful health effects exists. If a substance is listed in the latest printed RTECS, the regulation applies to exposure and medical records (and analyses of these records) relevant to employees exposed to the substance.

It is appropriate to note that the final regulation does not require that employers purchase a copy of RTECS, and many employers need not consult RTECS to ascertain whether their employee exposure or medical records are subject to the rule. Employers who do not currently have the latest printed edition of the NIOSH RTECS, however, may desire to obtain a copy. The RTECS is issued in an annual printed edition as mandated by section 20(a)(6) of the Occupational Safety and Health Act (29 U.S.C. 669(a)(6)).

The introduction to the 1980-printed edition describes the RTECS as follows:

"The 1980 edition of the Registry of Toxic Effects of Chemical Substances, formerly known as the

Toxic Substances list, is the ninth revision prepared in compliance with the requirements of Section 20(a)(6) of the Occupational Safety and Health Act of 1970 (Public Law 91-596). The original list was completed on June 28, 1971, and has been updated annually in book format. Beginning in October 1977, quarterly revisions have been provided in microfiche. This edition of the Registry contains 168,096 listings of chemical substances; 45,156 are names of different chemicals with their associated toxicity data and 122,940 are synonyms. This edition includes approximately 5,900 new chemical compounds that did not appear in the 1979 Registry. (p. xi)

"The Registry's purposes are many, and it serves a variety of users. It is a single source document for basic toxicity information and for other data, such as chemical identifiers and information necessary for the preparation of safety directives and hazard evaluations for chemical substances. The various types of toxic effects linked to literature citations provide researchers and occupational health scientists with an introduction to the toxicological literature, making their own review of the toxic hazards of a given substance easier. By presenting data on the lowest reported doses that produce effects by several routes of entry in various species, the Registry furnishes valuable information to those responsible for preparing safety data sheets for chemical substances in the workplace. Chemical and production engineers can use the Registry to identify the hazards which may be associated with chemical intermediates in the development of final products, and thus can more readily select substitutes or alternate processes which may be less hazardous. Some organizations, including health agencies and chemical companies, have included the NIOSH Registry accession numbers with the listing of chemicals in their files to reference toxicity information associated with those chemicals. By including foreign language chemical names, a start has been made toward providing rapid identification of substances produced in other countries. (p. xi)

"In this edition of the Registry, the editors intend to identify "all known toxic substances" which may exist in the environment and to provide pertinent data on the toxic effects from known doses entering an organism by any route described. (p. xi)

"It must be reemphasized that the entry of a substance in the Registry does not automatically mean that it must be avoided. A listing does mean, however, that the substance has the documented potential of being harmful if misused, and care must be exercised to prevent tragic consequences. Thus the Registry lists many substances that are common in everyday life and are in nearly every household in the United States. One can name a variety of such dangerous Substances: prescription and non-prescription drugs; food additives; pesticide concentrates, sprays, and dusts; fungicides; herbicides, paints; glazes, dyes; bleaches and other household cleaning agents; alkalis; and various solvents and diluents. The list is extensive because chemicals have become an integral part of our existence."

The RTECS printed edition may be purchased from the Superintendent of Documents, U.S. Government Printing Office (GPO), Washington, DC 20402 (202-783-3238). Some employers may desire to subscribe to the quarterly update to the RTECS that is published in a microfiche edition. An annual subscription to the quarterly microfiche may be purchased from the GPO (Order the "Microfiche Edition, Registry of Toxic Effects of Chemical Substances"). Both the printed edition and the microfiche edition of RTECS are available for review at many university and public libraries throughout the country.

The latest RTECS editions may also be examined at the OSHA Technical Data Center, Room N2439--Rear, United States Department of Labor, 200 Constitution Avenue, NW., Washington, DC 20210 (202-523-9700), or at any OSHA Regional or Area Office (See, major city telephone directories under United States Government-Labor Department).

§12-202-4 Threshold limit values. REPEALED. [Eff 7/12/82; R 6/18/84]
(Auth: HRS §396-4) (Imp: HRS §396-4)

§12-202-4.01 Permissible Exposure Levels. REPEALED. [Eff 6/16/84;
R 3/22/91] (Auth: HRS §396-4) (Imp: HRS §396-4)

§12-202-4.02 Air contaminants. (a) An employee's exposure to any substance listed in tables 202-1 and 202-2 in this section, or table 202-3 in section 12-202-9 shall be limited in accordance with the requirements of this section.

(1) Air Contaminants Limits Column. An employee's exposure to any substance listed in table 202-1 shall not exceed the PEL-TWA, PEL-STEL and PEL-Ceiling specified for that substance shown in table 202-1.

(A) Because many industrial exposures are not continuous, but

instead are short-term, or intermittent, to which the PEL-TWAs cannot be applied, PEL-STELs for selected air contaminants are listed in table 202-1.

- (B) The PEL-STELs listed in table 202-1 are 15-minute time-weighted average (TWA) exposures that shall not be exceeded at any time during a workday.
- (C) Exposures at the PEL-STEL shall not be longer than 15-minutes and shall not be repeated more than four times per day. There shall be at least 60 minutes between successive exposures at the PEL-STEL.
- (2) Skin Designation. To prevent or reduce skin absorption, an employee's skin exposure to substances listed in table 202-1 with an "X" in the Skin Designation columns shall be prevented or reduced to the extent necessary in the circumstances through the use of gloves, coveralls, goggles, or other appropriate personal protective equipment, engineering controls, or work practices.
- (b) Table 202-2.
 - (1) PEL-TWA. An employee's exposure to any material listed in table 202-2, in any 7- to 8-hour work shift of a 40-hour workweek, shall not exceed the PEL-TWA given for that material in table 202-2.
 - (2) Acceptable ceiling concentration. An employee's exposure to a material listed in table 202-2 shall not exceed at any time during a 7- to 8-hour work shift the acceptable ceiling concentration given for that material in the table.
- (c) Effective date. The effective date for the permissible exposure limits specified in the Air Contaminants Limits column of table 202-1 is six months after the effective date of this standard.
- (d) Enforcement of the limits are indefinitely stayed for: aluminum alkyls; ethylidene norbornene; hexafluoroacetone; mercury (alkyl compounds); oxygen difluoride; phenylphosphine; and sulfur pentafluoride; until OSHA publishes in the Federal Register a notice that adequate sampling and analytical techniques are developed.

TABLE 202-1 Limits for Air Contaminants¹

		Air Contaminant Limits**						Skin Desig- nation
		PEL-TWA*		PEL-STEL ^a		PEL-CEILING		
Substance	CAS No. ^b	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	
Acetaldehyde	75-07-0	100	180	150	270	-	-	-
Acetic acid	64-19-7	10	25	15	37	-	-	-
Acetic anhydride	108-24-7	-	-	-	-	5	20	-
Acetone	67-64-1	750	1,780	1,000	2,375	-	-	-
Acetonitrile	75-05-8	40	70	60	105	-	-	X
2-Acetylaminofluorene	53-96-3	See §12-202-14.1						
Acetylene dichloride		See 1,2-Dichloroethylene						
Acetylene ttrabromide	79-27-6	1	14	1.5	20	-	-	-
Acetylsalicylic acid (Aspirin)	50-78-2	-	5	-	-	-	-	-
Acrolein	107-02-8	0.1	0.25	0.3	0.8	-	-	-
Acrylamide	79-06-1	-	0.03	-	-	-	-	X
Acrylic acid	79-10-7	2	6	-	-	-	-	X
Acrylonitrile	107-13-1	See §12-202-30						
Aldrin	309-00-2	-	0.25	-	0.75	-	-	X
Allyl alcohol	107-18-6	2	5	4	10	-	-	X
Allyl chloride	107-05-1	1	3	2	6	-	-	-
Allyl glycidyl ether (AGE)	106-92-3	5	22	10	44	-	-	X
Allyl propyl disulfide	2179-59-1	2	12	3	18	-	-	-
∇- Alumina	1344-28-1							
Total dust		-	10	-	20	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Aluminum (as Al)	7429-90-5							
Metal & oxide								
Total dust		-	10	-	20	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Pyro powders		-	5	-	-	-	-	-
Welding fumes		-	5	-	-	-	-	-
Soluble salts		-	2	-	-	-	-	-
Alkyls		-	2	-	-	-	-	-
4-Aminodiphenyl	92-67-1	See §12-202-14.1						
2-Aminoethanol		See Ethanolamine						
2-Aminopyridine	504-29-0	0.5	2	2	4	-	-	-
Amitrole	61-82-5	-	0.2	-	-	-	-	-
Ammonia	7664-41-7	25	18	35	27	-	-	-
Ammonium chloride	12125-02-9	-	10	-	20	-	-	-
Fume								
Ammonium sulfamate	7773-06-0							
Total dust		-	10	-	20	-	-	-
Respirable fraction		-	5	-	-	-	-	-
n-Amyl acetate	628-63-7	100	525	150	800	-	-	-
sec-Amyl acetate	626-38-0	125	650	150	800	-	-	-
Aniline and homologs	62-53-3	2	8	5	20	-	-	X

TABLE 202-1 Limits for Air Contaminants¹

Substance	CAS No. ^b	Air Contaminant Limits**						Skin Designation
		PEL-TWA*		PEL-STEL ^a		PEL-CEILING		
		ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	
Anisidine (o-, p-isomers)	29191-52-4	0.1	0.5	-	-	-	-	X
Antimony and compounds (as Sb)	7440-36-0	-	0.5	-	-	-	-	-
Antimony trioxide	1309-64-4	-	0.5	-	-	-	-	-
Handling and use, as Sb		-	0.5	-	-	-	-	-
ANTU (Alpha Naphthylthiourea)	86-88-4	-	0.3	-	0.9	-	-	-
Arsenic, organic compounds (as As)	7440-38-2	-	0.2	-	-	-	-	-
Arsenic, inorganic compounds, (as As)	7440-38-2	See §12-202-31						-
Arsine	7784-42-1	0.05	0.2	-	-	-	-	-
Asbestos	Varies	See §12-206 and 12-145						-
Asphalt (petroleum) fumes	8052-42-4	-	5	-	10	-	-	-
Atrazine	1912-24-9	-	5	-	-	-	-	-
Azinphos-methyl	86-50-0	-	0.2	-	0.6	-	-	X
Barium, soluble compounds (as Ba)	7440-39-3	-	0.5	-	-	-	-	-
Barium sulfate	7727-43-7	-	10	-	-	-	-	-
Total dust		-	5	-	-	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Benomy	117804-35-2	-	10	1.3	15	-	-	-
Total dust		-	5	-	-	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Benzene; see §12-202-36	71-43-2	See Table 202-2 for operations excluded						-
Benzidine	92-87-5	See §12-202-14.1						-
p-Benzoquinone		See Quinone						-
Benzo(a)pyrene		See Coal tar pitch volatiles						-
Benzoyl peroxide	94-36-0	-	5	-	-	-	-	-
Benzyl chloride	100-44-7	1	5	-	-	-	-	-
Beryllium and beryllium compounds (as Be)	7440-41-7	0.002		0.005		0.025		-
				(see Table 202-2)				-
Biphenyl		See Diphenyl						-
Bismuth telluride, Undoped	1304-82-1	-	10	-	20	-	-	-
Total dust		-	5	-	-	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Bismuth telluride, Se-doped		-	5	-	10	-	-	-
Borates, tetra, sodium salts		-	5	-	10	-	-	-

TABLE 202-1 Limits for Air Contaminants¹ (Continued)

		Air Contaminant Limits**						Skin Design- nation
		PEL-TWA*		PEL-STEL ^a		PEL-CEILING		
Substance	CAS No. ^b	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	
Anhydrous	1330-43-4	-	1	-	-	-	-	-
Decahydrate	1303-96-4	-	5	-	-	-	-	-
Pentahydrate	12179-04-3	-	1	-	-	-	-	-
Boron oxide	1303-86-2							
total dust		-	10	-	20	-	-	-
Respirable fraction		-	-	-	-	-	-	-
Boron tribromide	10294-33-4	-	-	-	-	1	10	-
Boron trifluoride	7637-07-2	-	-	-	-	1	3	-
Bromacil	314-40-9	1	10	2	20	-	-	-
Bromine	7726-95-6	0.1	0.7	0.3	2	-	-	-
Bromine pentafluoride	7789-30-2	0.1	0.7	0.3	2	-	-	-
Bromoform	75-25-2	0.5	5	-	-	-	-	X
Butadiene (1,3- Butadiene)	106-99-0	See §12-202-40						
Butane	106-97-8	800	1,900	-	-	-	-	-
Butanethiol		See Butyl mercaptan						
2-Butanone (Methyl ethyl ketone) (MEK)	8-93-3	200	590	300	885	-	-	-
2-Butoxyethanol	111-76-2	25	120	75	360	-	-	X
n-Butyl acetate	123-86-4	150	710	200	950	-	-	-
sec-Butyl acetate	105-46-4	200	950	250	1,190	-	-	-
tert-Butyl acetate	540-88-5	200	950	250	1,190	-	-	-
Butyl acrylate	141-32-2	10	55	-	-	-	-	-
n-Butyl alcohol	71-36-3	-	-	-	-	50	150	X
sec-Butyl alcohol	78-92-2	100	305	150	455	-	-	-
tert-Butyl alcohol	75-65-0	100	300	150	450	-	-	-
Butylamine	109-73-9	-	-	-	-	5	15	X
tert-Butyl chromate (as CrO3)	1189-85-1	-	-	-	-	-	0.1	X
n-Butyl glycidyl ether (BGE)	2426-08-6	25	135	-	-	-	-	-
n-Butyl lactate	138-22-7	5	25	-	-	-	-	-
Butyl mercaptan	109-79-5	0.5	1.5	-	-	-	-	-
o-sec Butylphenol	89-72-5	5	30	-	-	-	-	X
p-tert-Butyltoluene	98-51-1	10	60	20	120	-	-	-
Cadmium fume (as Cd)	7440-43-9	-	-	-	-	-	0.05	-
Cadmium dust (as Cd)	7440-43-9	-	0.05	-	-	-	0.2	-
Calcium carbonate	1317-65-3							
Total dust		-	10	-	20	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Calcium cyanamide	156-62-7	-	0.5	-	1	-	-	-
Calcium hydroxide	1305-62-0	-	5	-	-	-	-	-
Calcium oxide	1305-78-8	-	2	-	-	-	-	-
Calcium silicate	1344-95-2							
Total dust		-	10	-	-	-	-	-

TABLE 202-1 Limits for Air Contaminants¹ (Continued)

		Air Contaminant Limits**						
		PEL-TWA*		PEL-STEL ^a		PEL-CEILING		Skin Designation
Substance	CAS No. ^b	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	
Respirable fraction		-	5	-	-	-	-	-
Calcium sulfate	7778-18-9							
Total dust		-	10	-	-	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Camphor, synthetic	76-22-2	0.3	2	-	-	-	-	-
Caprolactam	105-60-2							
Dust		-	1	-	3	-	-	-
Vapor & Aerosol		5	20	-	40	-	-	-
Captafol (DifolatanR)	2425-06-1	-	0.1	-	-	-	-	-
Captan	133-06-2	-	5	-	15	-	-	-
Carbaryl (SevinR)	63-25-2	-	5	-	10	-	-	-
Carbofuran (FuradanR)	1563-66-2	-	0.1		-	-	-	-
	-							
Carbon black	1333-86-4	-	3.5	-	7	-	-	-
Carbon dioxide	124-38-9	5,000	9,000	15,000	27,000	-	-	-
Carbon disulfide	75-15-0	4	12	12	36	-	-	X
Carbon monoxide	630-08-0	35	40			200	229	-
Carbon tetrabromide	558-13-4	0.1	1.4	0.3	4	-	-	X
Carbon tetrachloride	56-23-5	2	12.6	-	-	-	-	-
Carbonyl fluoride	353-50-4	2	5	5	15	-	-	-
Catechol (Pyrocatechol)	120-80-9	5	20	-	-	-	-	X
Cellulose	9004-34-6							
Total dust		-	10	-	20	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Cesium hydroxide	21351-79-1	-	2	-	-	-	-	-
Chlordane	57-74-9	-	0.5	-	2	-	-	X
Chlorinated camphene	8001-35-2	-	0.5	-	1	-	-	X
Chlorinated diphenyl Oxide	55720-99-5	-	0.5	-	2	-	-	-
Chlorine	7782-50-5	0.5	1.5	1	3	-	-	-
Chlorine dioxide	10049-04-4	0.1	0.3	0.3	0.9	-	-	-
Chlorine trifluoride	7790-91-2	-	-	-	-	0.1	0.4	-
Chloroacetaldehyde	107-20-0	-	-	-	-	1	3	-
Chloroacetone	78-95-5	-	-	-	-	1	4	X
α- Chloroacetophenone (Phenacyl chloride)	532-27-4	0.05	0.3	-	-	-	-	-
Chloroacetyl chloride	79-04-9	0.05	0.2	-	-	-	-	-
Chlorobenzene	108-90-7	75	350	-	-	-	-	-
O-Chlorobenzylidene malononitrile	2698-41-1	-	-	-	-	0.05	0.4	X
Chlorobromomethane	74-97-5	200	1,050	250	1,300	-	-	-
2-Chloro-1,3-Butadiene		see β-Chloroprene						
Chlorodifluoromethane	75-45-6	1,000	3,500	1,250	4,375	-	-	-

TABLE 202-1 Limits for Air Contaminants¹ (Continued)

Substance	CAS No. ^b	Air Contaminant Limits**						Skin Designation
		PEL-TWA*		PEL-STEL ^a		PEL-CEILING		
		ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	
Chlorodiphenyl (42% chlorine) (PCB)	53469-21-9	-	1	-	2	-	-	X
Chlorodiphenyl (54% Chlorine) (PCB)	11097-69-1	-	0.5	-	1	-	-	X
1-Chloro, 2,3-epoxypropane		See Epichlorohydrin						
2-Chloroethanol		See Ethylene chlorohydrin						
Chloroethylene		See Vinyl chloride						
Chloroform (Trichloromethane)	67-66-3	2	9.78	-	-	-	-	-
bis(Chloromethyl) ether	542-88-1	see §12-202-14.1						
Chloromethyl methyl ether	107-30-2	see §12-202-14.1						
1-Chloro-1-nitropropane	600-25-9	2	10	-	-	-	-	-
Chloropentafluoroethane	76-15-3	1,000	6,320	-	-	-	-	-
Chloropicrin	76-06-2	0.1	0.7	0.3	2	-	-	-
β-Chloroprene	126-99-8	10	35	-	-	-	-	X
o-Chlorostyrene	2039-87-4	50	285	75	428	-	-	-
o-Chlorotoluene	95-49-8	50	250	75	375	-	-	X
2-Chloro-6- (trichloro-methyl) pyridine	1929-82-4							
Total dust		-	10	-	20	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Chlorpyrifos	2921-88-2	-	0.2	-	0.6	-	-	X
Chromic acid and chromates (as CrO3)	Varies with compound	-	-	-	-	-	0.1	-
Chromite ore processing (Chromate), (as Cr)		-	0.05	-	-	-	-	-
Chromium (II)	7440-47-3	-	0.5	-	-	-	-	-
Chromium (III) compounds (as Cr)	7440-47-3	-	0.5	-	-	-	-	-
Chromium (VI) compounds (as Cr)		-	0.05	-	-	-	-	-
Water soluble & insoluble								
Chromium metal (as Cr)	7440-47-3	-	0.5	-	-	-	-	-
Chromyl chloride	14977-61-8	0.025	0.15	-	-	-	-	-
Chrysene		See Coal tar pitch volatiles						
Clopidol	2971-90-6							
Total dust		-	10	-	20	-	-	-
Respirable fraction		-	5	-	-	-	-	-

TABLE 202-1 Limits for Air Contaminants¹ (Continued)

Substance	CAS No. ^b	Air Contaminant Limits**						Skin Desig- nation
		PEL-TWA*		PEL-STEL ^a		PEL-CEILING		
		ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	
Coal dust (less than 5% SiO2), Respirable fraction		-	2	-	-	-	-	-
Coal dust (greater than or equal to 5% SiO2), Respirable quartz fraction		-	0.1	-	-	-	-	-
Coal tar pitch volatiles (benzene soluble fraction), anthracene, BaP, phenanthrene, acridine, chrysene, pyrene	65966-93-2	-	0.2f	-	-	-	-	-
Cobalt metal, dust, and fume (as Co)	7440-48-4	-	0.05	-	-	-	-	-
Cobalt carbonyl (as Co)	10210-68-1	-	0.1	-	-	-	-	-
Cobalt hydrocarbonyl (as Co)	16842-03-8	-	0.1	-	-	-	-	-
Coke oven emissions		See §12-202-9						
Copper Fume (as Cu)	7440-50-8	-	0.1	-	-	-	-	-
Dusts and mists (as Cu)		-	1	-	2	-	-	-
Cotton dust (raw)		See §12-202-32						
Crag herbicide (Sesone) (Sodium 2,4-dichloro-phenoxyethyl sulfate)	136-78-7							
Total dust		-	10	-	20	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Cresol, all isomers	1319-77-3	5	22	-	-	-	-	X
Crotonaldehyde	123-73-9	2	6	6	18	-	-	-
	4170-30-3							
Crufomate	299-86-5	-	5	-	20	-	-	-
Cumene	98-82-8	50	245	75	365	-	-	X
Cyanamide	420-04-2	-	2	-	-	-	-	-
Cyanides (as CN)	Varies with compound	-	5	-	-	-	-	X
Cyanogen	460-19-5	10	20	-	-	-	-	-
Cyanogen chloride	506-77-4	-	-	-	-	0.3	0.6	-
Cyclohexane	110-82-7	300	1,050	375	1,300	-	-	-
Cyclohexanol	108-93-0	50	200	-	-	-	-	X
Cyclohexanone	108-94-1	25	100	100	400	-	-	X
Cyclohexene	110-83-8	300	1,015	-	-	-	-	-

TABLE 202-1 Limits for Air Contaminants¹ (Continued)

Substance	CAS No. ^b	Air Contaminant Limits**						Skin Designation
		PEL-TWA*		PEL-STEL ^a		PEL-CEILING		
		ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	
Cyclohexylamine	108-91-8	10	40	-	-	-	-	-
Cyclonite 121-82-4		-	1.5	-	3	-	-	X
Cyclopentadiene	542-92-7	75	200	75	200	-	-	-
Cyclopentane	287-92-3	600	1,720	900	2,580	-	-	-
Cyhexatin13121-70-5		-	5	-	10	-	-	-
2,4-D (Dichloryl-phenoxycetic acid)	94-75-7	-	10	-	20	-	-	-
DDT (Dichlorodiphenyl-trichloroethane)	50-29-3	-	1	-	3	-	-	X
Decaborane	17702-41-9	0.05	0.3	0.15	0.9	-	-	X
Demeton (SystoxR)	8065-48-3	-	0.1	0.03	0.3	-	-	X
Diacetone alcohol (4-hydroxy-4-methyl-2-pentanone)	123-42-2	50	240	75	360	-	-	-
1,2-Diaminoethane		See Ethylenediamine						
Diazinon	333-41-5	-	0.1	-	0.3	-	-	X
Diazomethane	334-88-3	0.2	0.4	-	-	-	-	-
Diborane	19287-45-7	0.1	0.1	-	-	-	-	-
1,2-Dibromo-3-chloropropane	96-12-8	See §12-202-29						
2-N-Dibutylamino-ethanol	102-81-8	2	14	4	28	-	-	X
Dibutyl phosphate	107-66-4	1	5	2	10	-	-	-
Dibutyl phthalate	84-74-2	-	5	-	10	-	-	-
Dichloroacetylene	7572-29-4	-	-	-	-	0.1	0.4	-
o-Dichlorobenzene	95-50-1	-	-	-	-	50	300	-
p-Dichlorobenzene	106-46-7	75	450	110	675	-	-	-
3,3'-Dichlorobenzidine	91-94-1	See §12-202-14.1						
Dichlorodifluoromethane	75-71-8	1,000	4,950	1,250	6,200	-	-	-
1,3-Dichloro-5,5-dimethyl hydantoin	118-52-5	-	0.2	-	0.4	-	-	-
1,1-Dichloroethane	75-34-3	100	400	250	1,010	-	-	-
1,2-Dichloroethylene	540-59-0	200	790	250	1,000	-	-	-
Dichloroethyl ether	111-44-4	5	30	10	60	-	-	X
Dichloromethane		See Methylene chloride						
Dichloromonofluoro-methane	75-43-4	10	40	-	-	-	-	-
1,1-Dichloro-1-nitro-ethane	594-72-9	2	10	10	60	-	-	-
1,2-Dichloropropane		See Propylene dichloride						
1,3-Dichloropropene	542-75-6	1	5	-	-	-	-	X
2,2-Dichloropropionic acid	75-99-0	1	6	-	-	-	-	-

TABLE 202-1 Limits for Air Contaminants¹ (Continued)

		Air Contaminant Limits**						Skin Designation
		PEL-TWA*		PEL-STEL ^a		PEL-CEILING		
Substance	CAS No. ^b	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	
Dichlorotetrafluoroethane	76-14-2	1,000	7,000	1,250	8,750	-	-	-
Dichlorvos (DDVP)	62-73-7	0.1	1	0.3	3	-	-	X
Dicrotophos	141-66-2	-	0.25	-	-	-	-	X
Dicyclopentadiene	77-73-6	5	30	-	-	-	-	-
Dicyclopentadienyl iron	102-54-5							
Total dust		-	10	-	20	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Dieldrin	60-57-1	-	0.25	-	0.75	-	-	X
Diethanolamine	111-42-2	3	15	-	-	-	-	-
Diethylamine	109-89-7	10	30	25	75	-	-	-
2-Diethylaminoethanol	100-37-8	10	50	-	-	-	-	X
Diethylene triamine	111-40-0	1	4	-	-	-	-	-
Diethyl ether		See Ethyl ether						
Diethyl ketone	96-22-0	200	705	-	-	-	-	-
Diethyl phthalate	84-66-2	-	5	-	10	-	-	-
Difluorodibromomethane	75-61-6	100	860	150	1,290	-	-	-
Diglycidyl ether (DGE)	2238-07-5	0.1	0.5	-	-	-	-	-
Dihydroxybenzene		See Hydroquinone						
Diisobutyl ketone	108-83-8	25	150	-	-	-	-	-
Diisopropylamine	108-18-9	5	20	-	-	-	-	X
4-Dimethylaminoazobenzene	60-11-7	See §12-202-14.1						
Dimethoxymethane		See Methylal						
Dimethyl acetamide	127-19-5	10	35	15	50	-	-	X
Dimethylamine	124-40-3	10	18	10	50	-	-	-
Dimethylaminobenzene		See Xylidine						
Dimethylaniline	121-69-7	5	25	10	50	-	-	X
(N-Dimethyl-aniline								
Dimethylbenzene		See Xylene						
Dimethyl-1, 2-dibromo-2,2-dichloroethyl phosphate	300-76-5	-	3	-	-	-	-	X
Dimethylformamide	68-12-2	10	30	20	60	-	-	X
2,6-Dimethyl-4-heptanone		See Diisobutyl ketone						
1,1-Dimethylhydrazine	57-14-7	0.5	1	1	2	-	-	X
Dimethylphthalate	131-11-3	-	5	-	10	-	-	-
Dimethyl sulfate	77-78-1	0.1	0.5	-	-	-	-	X
Dinitolmide (3,5-Dinitro-o-toluamide)	148-01-6	-	5	-	10	-	-	-

TABLE 202-1 Limits for Air Contaminants¹ (Continued)

Substance	CAS No. ^b	Air Contaminant Limits**						Skin Designation
		PEL-TWA*		PEL-STEL ^a		PEL-CEILING		
		ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	
Dinitrobenzene (all isomers) (alpha-)	528-29-0	0.15	1	0.5	1	-	-	X
(meta-)	99-65-0							
(para-)	100-25-4							
Dinitro-o-cresol	534-52-1	-	0.2	-	0.6	-	-	X
Dinitrotoluene	25321-14-6	-	1.5	-	5	-	-	X
Dioxane (Diethylene dioxide)	123-91-1	25	90	-	-	-	-	X
Dioxathion (Delnav)	78-34-2	-	0.2	-	-	-	-	X
Diphenyl (Biphenyl)	92-52-4	0.2	1.5	0.6	4	-	-	-
Diphenylamine	122-39-4	-	10	-	20	-	-	-
Diphenylmethane diisocyanate		See Methylene bisphenyl isocyanate						
Dipropylene glycol methyl ether	34590-94-8	100	600	150	900	-	-	X
Dipropyl ketone	123-19-3	50	235	-	-	-	-	-
Diquat	85-00-7	-	0.5	-	1	-	-	-
Di-sec-octyl phthalate (Di-2-ethylhexyl-phthalate)	117-81-7	-	5	-	10	-	-	-
Disulfiram	97-77-8	-	2	-	5	-	-	-
Disulfoton	298-04-4	-	0.1	-	0.3	-	-	X
2,6-Di-tert-butyl-p-cresol	128-37-0	-	10	-	20	-	-	-
Diuron	330-54-1	-	10	-	-	-	-	-
Divinyl benzene	1321-74-0	10	50	-	-	-	-	-
Emery	112-62-9							
Total dust		-	10	-	-	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Endosulfan	115-29-7	-	0.1	-	0.3	-	-	X
Endrin	72-20-8	-	0.1	-	0.3	-	-	X
Epichlorohydrin	106-89-8	2	8	-	-	-	-	X
EPN	2104-64-5	-	0.5	-	2	-	-	X
1,2-Epoxypropane		See Propylene oxide						
2,3-Epoxy-1-propanol		See Glycidol						
Ethanethiol		See Ethyl mercaptan						
Ethanolamine	141-43-5	3	8	6	15	-	-	-
Ethion	563-12-2	-	0.4	-	-	-	-	X
2-Ethoxyethanol	110-80-5	5	19	-	-	-	-	X
2-Ethoxyethyl acetate (Cellosolve acetate)	111-15-9	5	27	-	-	-	-	X
Ethyl acetate	141-78-6	400	1,400	-	-	-	-	-
Ethyl acrylate	140-88-5	5	20	25	100	-	-	X
Ethyl alcohol (Ethanol)	64-17-5	1,000	1,900	-	-	-	-	-

TABLE 202-1 Limits for Air Contaminants¹ (Continued)

Substance	CAS No. ^b	Air Contaminant Limits**						Skin Designation
		PEL-TWA*		PEL-STEL ^a		PEL-CEILING		
		ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	
Ethylamine	75-04-7	10	18	-	-	-	-	-
Ethyl amyl ketone (5-Methyl-3-heptanone)	541-85-5	25	130	-	-	-	-	-
Ethyl benzene	100-41-4	100	435	125	545	-	-	-
Ethyl bromide	74-96-4	200	890	250	1,110	-	-	-
Ethyl butyl ketone (3-Heptanone)	106-35-4	50	230	75	345	-	-	-
Ethyl chloride	75-00-3	1,000	2,600	1,250	3,250	-	-	-
Ethyl ether	60-29-7	400	1,200	500	1,500	-	-	-
Ethyl formate	109-94-4	100	300	-	-	-	-	-
Ethyl mercaptan	75-08-1	0.5	1	-	-	-	-	-
Ethyl silicate	78-10-4	10	85	-	-	-	-	-
Ethylene chlorohydrin	107-07-3	-	-	-	-	1	3	X
Ethylenediamine	107-15-3	10	25	-	-	-	-	-
Ethylene dibromide	106-93-4	20	see §12-202-34			30		X
			See Table 202-2 for operations excluded					
Ethylene dichloride	107-06-2	1	4	2	8	-	-	-
Ethylene glycol, vapor	107-21-1	-	-	-	-	50	125	-
Ethylene glycol dinitrate (EGDN) ¹	628-96-6	0.05	0.3	-	0.1	-	-	X
Ethylene glycol methyl acetate		See Methyl cellosolve acetate						
Ethylene imine	151-56-4	See §12-202-14.1						
Ethylene oxide	75-21-8	See §12-202-35						
Ethylidene chloride		See 1,1-Dichloroethane						
Ethylidene norbornene	16219-75-3	-	-	-	-	5	25	-
N-Ethylmorpholine	100-74-3	5	23	-	-	-	-	X
Fenamiphos	22224-92-6	-	0.1	-	-	-	-	X
Fensulfothion (Dasanit)	115-90-2	-	0.1	-	-	-	-	-
Fenthion	55-38-9	-	0.2	-	-	-	-	X
Ferbaml	4484-64-1							
Total dust		-	10	-	20	-	-	-
Respirable fraction		-	-	-	-	-	-	-
Ferrovanadium dust	12604-58-9	-	1	-	3	-	-	-
Fibrous glass dust	-	-	10 ^h	-	-	-	-	-
Fluorides (as F)	Varies with compound	-	2.5	-	-	-	-	-
Fluorine	7782-41-4	0.1	0.2	-	-	-	-	-
Fluorotrichloromethane (Trichlorofluoromethane)	75-69-4	-	-	-	-	1,000	5,600	-
Fonofos	944-22-9	-	0.1	-	-	-	-	X
Formaldehyde	50-00-0	See §12-202-37						

TABLE 202-1 Limits for Air Contaminants¹ (Continued)

Substance	CAS No. ^b	Air Contaminant Limits**						Skin Desig- nation
		PEL-TWA*		PEL-STEL ^a		PEL-CEILING		
		ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	
Formamide	75-12-7	10	15	-	-	-	-	-
Formic acid	64-18-6	5	9	10	18	-	-	-
Furfural	98-01-1	2	8	-	-	-	-	X
Furfuryl alcohol	98-00-0	10	40	15	60	-	-	X
Gasoline	8006-61-9	300	900	-	-	-	-	-
Germanium tetrahydride	7782-65-2	0.2	0.6	0.6	1.8	-	-	-
Glutaraldehyde	111-30-8	-	-	-	-	0.2	0.7	-
Glycerin (mist)	56-81-5							
Total dust		-	10	-	-	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Glycidol	556-52-5	25	75	-	-	-	-	-
Glycol monoethyl ether		See 2-Ethoxyethanol						
Grain dust (oat, wheat, barley)	-	-	10	-	-	-	-	-
Graphite, natural respirable dust	7782-42-5	-	2.5	-	-	-	-	-
Graphite, synthetic	-							
Total dust		-	10	-	-	-	-	-
Respirable fraction		-	5	-	-	-	-	-
GuthionR		See Azinphos methyl						
Gypsum	13397-24-5							
Total dust		-	10	-	20	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Hafnium 7440-58-6		-	0.5	-	1.5	-	-	-
Heptachlor	76-44-8	-	0.5	-	2	-	-	X
Heptane (n-Heptane)	142-82-5	400	1,600	500	2,000	-	-	-
Hexachlorobutadiene	87-68-3	0.02	0.24	-	-	-	-	-
Hexachlorocyclo- pentadiene	77-47-4	0.01	0.1	0.03	0.3	-	-	-
Hexachloroethane	67-72-1	1	10	-	-	-	-	X
Hexachloronaphthalene	1335-87-1	-	0.2	-	0.6	-	-	X
Hexafluoroacetone	684-16-2	0.1	0.7	0.3	2	-	-	X
n-Hexane	110-54-3	50	180	-	-	-	-	-
Hexane isomers	Varies with compound	500	1,800	-	-	-	-	-
2-Hexanone (Methyl n-butyl ketone)	591-78-6	5	20	-	-	-	-	-
Hexone (Methyl isobutyl ketone	108-10-1	50	205	75	300	-	-	-
sec-Hexyl acetate	108-84-9	50	300	-	-	-	-	-
Hexylene glycol	107-41-5	-	-	-	-	25	125	-
Hydrazine	302-01-2	0.1	0.1	-	-	-	-	X
Hydrogenated Terphenyls	61788-32-7	0.5	5	-	-	-	-	-
Hydrogen bromide	10035-10-6	-	-	-	-	3	10	-

TABLE 202-1 Limits for Air Contaminants¹ (Continued)

Substance	CAS No. ^b	Air Contaminant Limits**						Skin Design- nation
		PEL-TWA*		PEL-STEL ^a		PEL-CEILING		
		ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	
Hydrogen chloride	7647-01-0	-	-	-	-	5	7	-
Hydrogen cyanide	74-90-8	-	-	4.7	5	-	-	X
Hydrogen fluoride (as F)	7664-39-3	3	-	6	-	-	-	-
Hydrogen peroxide	7722-84-1	1	1.4	2	3	-	-	-
Hydrogen selenide (as Se)	7783-07-5	0.05	0.2	-	-	-	-	-
Hydrogen sulfide	7783-06-4	10	14	15	21	-	-	-
Hydroquinone	123-31-9	-	2	-	4	-	-	-
2-Hydroxypropyl acrylate	999-61-1	0.5	3	-	-	-	-	X
Indene	95-13-6	10	45	15	70	-	-	-
Indium and compounds (as In)	7440-74-6	-	0.1	-	0.3	-	-	-
Iodine	7553-56-2	-	-	-	-	0.1	1	-
Iodoform	75-47-8	0.6	10	1	20	-	-	-
Iron oxide dust and fume (as Fe)	1309-37-1							
Total particulate		-	5	-	10	-	-	-
Iron pentacarbonyl (as Fe)13463-40-6		0.1	0.8	0.2	1.6	-	-	-
Iron salts (soluble) (as Fe)Varies with compound		-	1	-	2	-	-	-
Isoamyl acetate	123-92-2	100	525	125	655	-	-	-
Isoamyl alcohol (primary and secondary)	123-51-3	100	360	125	450	-	-	-
Isobutyl acetate	110-19-0	150	700	187	888	-	-	-
Isobutyl alcohol	78-83-1	50	150	75	225	-	-	-
Isooctyl alcohol	26952-21-6	50	270	-	-	-	-	X
Isophorone	78-59-1	4	23	-	-	5	28	-
Isophorone diiso- cyanate	4098-71-9	0.005	0.045	0.02	-	-	-	X
2-Isopropoxyethanol	109-59-1	25	105	75	320	-	-	-
Isopropyl acetate	108-21-4	250	950	310	1,185	-	-	-
Isopropyl alcohol	67-63-0	400	980	500	1,225	-	-	-
Isopropylamine	75-31-0	5	12	10	24	-	-	-
N-Isopropylaniline	768-52-5	2	10	-	-	-	-	X
Isopropyl ether	108-20-3	250	1,050	310	1,320	-	-	-
Isopropyl glycidyl ether (IGE)	4016-14-2	50	240	75	360	-	-	-
Kaolin	-							
Total dust		-	10	-	20	-	-	-
Respirable fraction		-	5	-	-	-	-	-

TABLE 202-1 Limits for Air Contaminants¹ (Continued)

Substance	CAS No. ^b	Air Contaminant Limits**						Skin Design- nation
		PEL-TWA*		PEL-STEL ^a		PEL-CEILING		
		ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	
Ketene	463-51-4	0.5	0.9	1.5	3	-	-	-
Lead chromate, as Cr	7758-97-6	-	0.05	-	-	-	-	-
Lead inorganic (as Pb)	7439-92-1	See §12-202-33.1 and 12-148.1						
Limestone	1317-65-3							
Total dust		-	10	-	20	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Lindane	58-89-9	-	0.5	-	1.5	-	-	X
Lithium hydride	7580-67-8	-	0.025	-	-	-	-	-
L.P.G. (Liquefied petroleum gas)	68476-85-7	1,000	1,800	1,250	2,250	-	-	-
Magnesite	546-93-0							
Total dust		-	10	-	20	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Magnesium oxide fume	1309-48-4							
Total particulate		-	10	-	-	-	-	-
Malathion	121-75-5							
Total dust		-	10	-	-	-	-	X
Maleic anhydride	108-31-6	0.25	1	-	-	-	-	-
Manganese compounds (as Mn)	7439-96-5	-	-	-	-	-	5	-
Manganese fume (as Mn)	7439-96-5	-	1	-	3	-	-	-
Manganese cyclopenta- dienyl tricarbonyl (as Mn)	12079-65-1	-	0.1	-	0.3	-	-	X
Manganese tetroxide (as Mn)	1317-35-7	-	1	-	-	-	-	-
Marble (Calcium carbonate)	1317-65-3							
Total dust		-	10	-	20	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Mercury (aryl and inorganic) (as Hg)	7439-97-6	-	-	-	-	-	0.1	X
Mercury (organo) alkyl compounds (as Hg)	7439-97-6	-	0.01	-	0.03	-	-	X
Mercury (vapor) (as Hg)	7439-97-6	-	0.05	-	-	-	-	X
Mesityl oxide	141-79-7	15	60	25	100	-	-	-
Methacrylic acid	79-41-4	20	70	-	-	-	-	X
Methanethiol		See Methyl mercaptan						
Methomyl (Lannate)	16752-77-5	-	2.5	-	-	-	-	-
Methoxychlor	72-43-5							
Total dust		-	10	-	-	-	-	-

TABLE 202-1 Limits for Air Contaminants¹ (Continued)

Substance	CAS No. ^b	Air Contaminant Limits**						Skin Designation
		PEL-TWA*		PEL-STEL ^a		PEL-CEILING		
		ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	
2-Methoxyethanol	150-76-5	See Methyl cellosolve						
4-Methoxyphenol								
Methyl acetate	79-20-9	200	610	250	760	-	-	-
Methyl acetylene (Propyne)	74-99-7	1,000	1,650	1,250	2,040	-	-	-
Methyl acetylene- propadiene mixture (MAPP)	-	1,000	1,800	1,250	2,250	-	-	-
Methyl acrylate	96-33-3	10	35	-	-	-	-	X
Methylacrylonitrile	126-98-7	1	3	2	6	-	-	X
Methylal (Dimethoxy- methane)	109-87-5	1,000	3,100	1,250	3,875	-	-	-
Methyl alcohol (methanol)	67-56-1	200	260	250	325	-	-	X
Methylamine	74-89-5	10	12	-	-	-	-	-
Methyl amyl alcohol		See Methyl isobutyl carbinol						
Methyl n-amyl ketone	110-43-0	50	235	-	-	-	-	-
N-Methyl aniline	100-61-8	0.5	2	1	5	-	-	X
Methyl bromide	74-83-9	5	20	15	60	-	-	X
Methyl n-butyl ketone		See 2-Hexanone						
Methyl cellosolve (2-Methoxyethanol)	109-86-4	5	16	-	-	-	-	X
Methyl cellosolve acetate (2-Methoxyethyl acetate)	110-49-6	5	24	-	-	-	-	X
Methyl chloride	74-87-3	50	105	106	205	200	-	-
Methyl chloroform (1,1,1-Trichloro- ethane)	71-55-6	350	1,900	450	2,450	-	-	-
Methyl 2-cyanoacrylate	137-05-3	2	8	4	16	-	-	-
Methylcyclohexane	108-87-2	400	1,600	500	2,000	-	-	-
Methylcyclohexanol	25639-42-3	50	235	75	350	-	-	-
o-Methylcyclohexanone	538-60-8	50	230	75	345	-	-	X
2-Methylcyclo- pentadienyl manganese tricarbonyl (as Mn)	12108-13-3	-	0.2	-	0.6	-	-	X
Methyl demeton	8022-00-2	-	0.5	-	1.5	-	-	X
4,4'-Methylene bis (2-chloroaniline) (MBOCA)	101-14-4	0.02	0.22	-	-	-	-	X
Methylene bis (4- cyclohexyliso- cyanate)	5124-30-1	-	-	-	-	0.01	0.11	-

TABLE 202-1 Limits for Air Contaminants¹ (Continued)

Substance	CAS No. ^b	Air Contaminant Limits**						Skin Desig- nation
		PEL-TWA*		PEL-STEL ^a		PEL-CEILING		
		ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	
Methylene chloride	75-09-2	See §12-202-41						
4,4'-Methylene dianiline;	101-77-9	See §12-202-38 and 12-146						
Methyl ethyl ketone (MEK)		See 2-Butanone						
Methyl ethyl ketone peroxide (MEKP)	1338-23-4	-	-	-	-	0.2	1.5	-
Methyl formate	107-31-3	100	250	150	375	-	-	-
Methyl hydrazine (Mono-methyl hydrazine)	60-34-4	-	-	-	-	0.2	0.35	X
Methyl iodide	74-88-4	2	10	-	-	-	-	X
Methyl isoamyl ketone	110-12-3	50	240	-	-	-	-	-
Methyl isobutyl carbinol	108-11-2	25	100	-	-	-	-	X
Methyl isobutyl ketone		See Hexone						
Methyl isocyanate	624-83-9	0.02	0.05	-	-	-	-	X
Methyl isopropyl Ketone	563-80-4	200	705	-	-	-	-	-
Methyl mercaptan	74-93-1	0.5	1	-	-	-	-	-
Methyl methacrylate	80-62-6	100	410	-	-	-	-	-
Methyl parathion	298-00-0	-	0.2	-	0.6	-	-	X
Methyl propyl ketone		See 2-Pentanone						
Methyl silicate	681-84-5	1	6	-	-	-	-	-
α- Methyl styrene	98-83-9	50	240	100	485	-	-	-
Methylene bisphenyl isocyanate (MDI)	101-68-8	-	-	-	-	0.02	0.2	-
Metribuzin	21087-64-9	-	5	-	-	-	-	-
MevinphosR		See Phosdrin						
Mica		See Silicates						
Molybdenum (as Mo) Soluble compounds	7439-98-7	-	5	-	10	-	-	-
Insoluble compounds		-	10	-	20	-	-	-
Total dust		-	0.25	-	-	-	-	-
Monocrotophos (AzodrinR)	6923-22-4	-	-	-	-	-	-	-
Monomethyl aniline (N-Methylaniline)	100-61-8	0.5	2	-	-	-	-	X
Morpholine	110-91-8	20	70	30	105	-	-	X
Naled 300-76-5		-	3	-	6	-	-	X
Naphtha (Coal tar)	8030-30-6	100	400	-	-	-	-	-
Naphthalene	91-20-3	10	50	15	75	-	-	-
α- Naphthylamine	134-32-7	See §12-202-14.1						

TABLE 202-1 Limits for Air Contaminants¹ (Continued)

Substance	CAS No. ^b	Air Contaminant Limits**						Skin Designation
		PEL-TWA*		PEL-STEL ^a		PEL-CEILING		
		ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	
β-naphthylamine	91-59-8	See §12-202-14.1						
Nickel carbonyl (as Ni)	13463-39-3	0.001	0.007	-	-	-	-	-
Nickel, metal and insoluble compounds (as Ni) 7440-02-0		-	1	-	-	-	-	-
Nickel, soluble compounds (as Ni)	7440-02-0	-	0.1	-	0.3	-	-	-
Nickel sulfide roasting, fume & dust, (as Ni)	-	-	1	-	-	-	-	-
Nicotine	54-11-5	-	0.5	-	1.5	-	-	X
Nitrapyrin	1929-82-4	-	10	-	20	-	-	-
Nitric acid	7697-37-2	2	5	4	10	-	-	-
Nitric oxide	10102-43-9	25	30	35	45	-	-	-
p-Nitroaniline	100-01-6	-	3	-	-	-	-	X
Nitrobenzene	98-95-3	1	5	2	10	-	-	X
p-Nitrochlorobenzene	100-00-5	0.1	0.6	-	-	-	-	X
4-Nitrodiphenyl	92-93-3	See §12-202-14.1						
Nitroethane	79-24-3	100	310	150	465	-	-	-
Nitrogen dioxide	10102-44-0	3	6	5	9.4	-	-	-
Nitrogen trifluoride	7783-54-2	10	29	15	45	-	-	-
Nitroglycerin (NG) ¹	55-63-0	-	-	-	0.1	-	-	X
Nitromethane	75-52-5	100	250	150	375	-	-	-
1-Nitropropane	108-03-2	25	90	35	135	-	-	-
2-Nitropropane	79-46-9	10	35	-	-	-	-	-
N-Nitrosodi- methylamine	62-79-9	See §12-202-14.1						
Nitrotoluene								
o-isomer	88-72-2;	2	11	-	-	-	-	X
m-isomer	99-08-1;	2	11	-	-	-	-	X
p-isomer	99-99-0	2	11	-	-	-	-	X
Nitrotrichloromethane		See Chloropicrin						
Nitrous oxide	10024-97-2	50	91	-	-	-	-	-
Nonane	111-84-2	200	1,050	250	1,300	-	-	-
Octachloronaphthalene	2234-13-1	-	0.1	-	0.3	-	-	X
Octane	111-65-9	300	1,450	375	1,800	-	-	-
Oil mist, mineral	8012-95-1	-	5i	-	10i	-	-	-
Osmium tetroxide (as Os)	20816-12-0	0.0002	0.002	0.0006	0.006	-	-	-
Oxalic acid	144-62-7	-	1	-	2	-	-	-
Oxygen difluoride	7783-41-7	-	-	-	-	0.05	0.11	-
Ozone	10028-15-6	0.1	0.2	0.3	0.6	-	-	-
Paraffin wax fume	8002-74-2	-	2	-	6	-	-	-

TABLE 202-1 Limits for Air Contaminants¹ (Continued)

Substance	CAS No. ^b	Air Contaminant Limits**						Skin Designation
		PEL-TWA*		PEL-STEL ^a		PEL-CEILING		
		ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	
Paraquat, respirable dust	1910-42-5	-	0.1	-	-	-	-	X
	2074-50-2	-	0.1	-	-	-	-	X
	4685-14-7	-	0.1	-	-	-	-	X
Parathion	56-38-2	-	0.1	-	0.3	-	-	X
Particulates not otherwise regulated	-							
Total dust	-	-	10	-	-	-	-	-
Respirable fraction	-	-	5	-	-	-	-	-
Pentaborane	19624-22-7	0.005	0.01	0.015	0.03	-	-	-
Pentachloronaphthalene	1321-64-8	-	0.5	-	2	-	-	X
Pentachlorophenol	87-86-5	-	0.5	-	1.5	-	-	X
Pentaerythritol	115-77-5							
Total dust		-	10	-	20	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Pentane	109-66-0	600	1,800	750	2,250	-	-	-
2-Pentanone (Methyl propyl ketone)	107-87-9	200	700	250	875	-	-	-
Perchloroethylene (Tetrachloroethylene)	127-18-4	25	170	200	1,340	-	-	-
Perchloromethyl mercaptan	594-42-3	0.1	0.8	-	-	-	-	-
Perchloryl fluoride	7616-94-6	3	14	6	28	-	-	-
Perlite	-							
Total dust		-	10	-	-	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Petroleum distillates (Naphtha)	8002-05-9	400	1,600	-	-	-	-	-
Phenol	108-95-2	5	19	10	38	-	-	X
Phenothiazine	92-84-2	-	5	-	10	-	-	X
p-Phenylene diamine	106-50-3	-	0.1	-	-	-	-	X
Phenyl ether, vapor	101-84-8	1	7	2	14	-	-	-
Phenyl ether-biphenyl mixture, vapor	-	1	7	-	-	-	-	-
Phenylethylene		See Styrene						
Phenyl glycidyl ether (PGE)	122-60-1	1	6	-	-	-	-	-
Phenylhydrazine	100-63-0	5	20	10	45	-	-	X
Phenyl mercaptan	108-98-5	0.5	2	-	-	-	-	-
Phenylphosphine	638-21-1	-	-	-	-	0.05	0.25	-
Phorate	298-02-2	-	0.05	-	0.2	-	-	X
Phosdrin (Mevinphos [®])	7786-34-7	0.01	0.1	0.03	0.3	-	-	X

TABLE 202-1 Limits for Air Contaminants¹ (Continued)

Substance	CAS No. ^b	Air Contaminant Limits**						Skin Designation
		PEL-TWA*		PEL-STEL ^a		PEL-CEILING		
		ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	
Phosgene (Carbonyl chloride)	75-44-5	0.1	0.4	-	-	-	-	-
Phosphine	7803-51-2	0.3	0.4	1	1.4	-	-	-
Phosphoric acid	7664-38-2	-	1	-	3	-	-	-
Phosphorus (yellow)	7723-14-0	-	0.1	-	0.3	-	-	-
Phosphorus oxychloride	10025-87-3	0.1	0.6	0.5	3	-	-	-
Phosphorus penta-Chloride	10026-13-8	-	1	-	3	-	-	-
Phosphorus penta-sulfide 1314-80-3	-	1	-	3	-	-	-	-
Phosphorus trichloride	7719-12-2	0.2	1.5	0.5	3	-	-	-
Phthalic anhydride	85-44-9	1	6	-	-	-	-	-
m-Phthalodinitrile	626-17-5	-	5	-	-	-	-	-
Picloram	1918-02-1	-	-	-	-	-	-	-
Total dust		-	10	-	20	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Picric acid	88-89-1	-	0.1	-	0.3	-	-	X
Pindone (2-Pivalyl-1,3-indandione)	83-26-1	-	0.1	-	0.3	-	-	-
Piperazine dihydro-chloride	142-64-3	-	5	-	-	-	-	-
Plaster of Paris	26499-65-0	-	-	-	-	-	-	-
Total dust		-	10	-	-	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Platinum (as Pt)	7440-06-4	-	1	-	-	-	-	-
Metal		-	0.002	-	-	-	-	-
Soluble salts		-	-	-	-	-	-	-
Portland cement	65997-15-1	-	-	-	-	-	-	-
Total dust		-	10	-	-	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Potassium hydroxide	1310-58-3	-	-	-	-	-	2	-
Propane	74-98-6	1,000	1,800	-	-	-	-	-
Propargyl alcohol	107-19-7	1	2	3	6	-	-	X
β-Propriolactone	57-57-8	See §12-202-14.1						-
Propionic acid	79-09-4	10	30	15	45	-	-	-
Propoxur (Baygon)	114-26-1	-	0.5	-	2	-	-	-
n-Propyl acetate	109-60-4	200	840	250	1,050	-	-	-
n-Propyl alcohol	71-23-8	200	500	250	625	-	-	X
n-Propyl Nitrate	627-13-4	25	105	40	170	-	-	-
Propylene dichloride	78-87-5	75	350	110	510	-	-	-
Propylene glycol dinitrate (PGDN)	6423-43-4	0.05	0.3	0.1	0.6	-	-	X
Propylene glycol mono-methyl ether	107-98-2	100	360	150	540	-	-	-
Propylene imine	75-55-8	2	5	-	-	-	-	X

TABLE 202-1 Limits for Air Contaminants¹ (Continued)

Substance	CAS No. ^b	Air Contaminant Limits**						Skin Design- ation
		PEL-TWA*		PEL-STEL ^a		PEL-CEILING		
		ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	
Propylene oxide	75-56-9	20	50	-	-	-	-	-
n-Propyl nitrate	627-13-4	25	105	40	170	-	-	-
Propyne		See Methyl acetylene						
Pyrethrum	8003-34-7	-	5	-	10	-	-	-
Pyridine	110-86-1	5	15	10	30	-	-	-
Quinone	106-51-4	0.1	0.4	0.3	1	-	-	-
Resorcinol	108-46-3	10	45	20	90	-	-	-
Rhodium (as Rh), metal fume and insoluble compounds	7440-16-6	-	0.1	-	-	-	-	-
Rhodium (as Rh), soluble compounds	7440-16-6	-	0.001	-	-	-	-	-
Ronnel	299-84-3	-	10	-	-	-	-	-
Rosin core solder pyrolysis products, as formaldehyde	-	-	0.1	-	0.3	-	-	-
Rotenone (commercial)	83-79-4	-	5	-	10	-	-	-
Rouge	-	-	-	-	-	-	-	-
Total dust		-	10	-	20	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Rubber solvent (Naphtha)	-	400	1,600	-	-	-	-	-
Selenium compounds (as Se) 7782-49-2	-	0.2	-	-	-	-	-	-
Selenium hexafluoride (as Se)	7783-79-1	0.05	0.2	-	-	-	-	-
Sesone (Sodium 2,4- dichloro-phenoxy- ethyl sulfate)		See Crag herbicide						
Silane		See Silicone tetrahydride						
Silica, amorphous, precipitated and gel	-	-	6	-	-	-	-	-
Silica, amorphous, diatomaceous earth containing less than 1% crystalline silica ⁶ 1790-53-2	-	6	-	-	-	-	-	-
Silica, crystalline cristobalite (as quartz), respirable dust	14464-46-1	-	0.05	-	-	-	-	-
Silica, crystalline quartz (as quartz), respirable dust	14808-60-7	-	0.1	-	-	-	-	-

TABLE 202-1 Limits for Air Contaminants¹ (Continued)

Substance	CAS No. ^b	Air Contaminant Limits**						Skin Designation
		PEL-TWA*		PEL-STEL ^a		PEL-CEILING		
		ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	
Silica, crystalline tripoli (as quartz), respirable dust	1317-95-9	-	0.1	-	-	-	-	-
Silica, crystalline tridymite (as quartz), respirable dust	15468-32-3	-	0.05	-	-	-	-	-
Silica, fused, respirable dust	60676-86-0	-	0.1	-	-	-	-	-
Silicates (less than 1% crystalline silica)								
Mica (respirable dust)	12001-26-2	-	3	-	-	-	-	-
Soapstone, total dust	-	-	6	-	-	-	-	-
Soapstone, respirable dust	-	-	3	-	-	-	-	-
Talc (containing asbestos): use asbestos limit	-	See §12-202-13						
Talc (containing no asbestos), respirable dust	14807-96-6	-	2	-	-	-	-	-
Tremolite		See §12-202-13						
Silicon	7440-21-3							
Total dust		-	10	-	20	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Silicon carbide	409-21-2							
Total dust		-	10	-	20	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Silicon tetrahydride (Silane)	7803-62-5	5	7	-	-	-	-	-
Silver, metal and soluble compounds (as Ag)	7440-22-4	-	0.01	-	-	-	-	-
Soapstone		See Silicates						
Sodium azide (as HN3)	26628-22-8	-	-	-	-	0.1	-	X
(as NaN3)		-	-	-	-	-	0.3	X
Sodium bisulfite	7631-90-5	-	5	-	-	-	-	-
Sodium 2,4-dichloro-phenoxyethyl sulfate		See Crag herbicide (see sessone)						
Sodium fluoroacetate	62-74-8	-	0.05	-	0.15	-	-	X

TABLE 202-1 Limits for Air Contaminants¹ (Continued)

Substance	CAS No. ^b	Air Contaminant Limits**						Skin Designation
		PEL-TWA*		PEL-STEL ^a		PEL-CEILING		
		ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	
Sodium hydroxide	1310-73-2	-	-	-	-	-	2	-
Sodium metabisulfite	7681-57-4	-	5	-	-	-	-	-
Starch	9005-25-8							
Total dust		-	10	-	20	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Stibine	7803-52-3	0.1	0.5	0.3	1.5	-	-	-
Stoddard solvent	8052-41-3	100	525	-	-	-	-	-
Strychnine	57-24-9	-	0.15	-	0.45	-	-	-
Styrene, monomer	100-42-5	50	215	100	425	-	-	-
Subtilisins (Proteolytic enzymes)	9014-01-1	-	-	-	0.00006 (60 min) ^j	-	-	-
Sucrose	57-50-1							
Total dust		-	10	-	20	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Sulfotep;		See TEDP						
Sulfur dioxide	7446-09-5	2	5	5	10	-	-	-
Sulfur hexafluoride	2551-62-4	1,000	6,000	1,250	7,500	-	-	-
Sulfuric acid	7664-93-9	-	1	-	3	-	-	-
Sulfur monochloride	10025-67-9	-	-	3	18	1	6	-
Sulfur pentafluoride	5714-22-7	-	-	0.075	0.75	0.01	0.1	-
Sulfur tetrafluoride	7783-60-0	-	-	0.3	1	0.1	0.4	-
Sulfuryl fluoride	2699-79-8	5	20	10	40	-	-	-
Sulprofos	35400-43-2	-	1	-	-	-	-	-
SystoxR		See Demeton 2,4,5-T						
Talc		See Silicates						
Tantalum, metal and oxide dust	7440-25-7	-	5	-	10	-	-	-
TEDP (Sulfotep)	3689-24-5	-	0.2	-	0.6	-	-	X
Tellurium and compounds (as Te)	13494-80-9	-	0.1	-	-	-	-	-
Tellurium hexafluoride (as Te)	7783-80-4	0.02	0.2	-	-	-	-	-
Temephos	3383-96-8							
Total dust		-	10	-	20	-	-	-
Respirable fraction		-	5	-	-	-	-	-
TEPP	107-49-3	0.004	0.05	0.01	0.2	-	-	X
Terphenyls	26140-60-3	-	-	-	-	0.5	5	-
1,1,1,2-Tetrachloro- 2,2-difluoroethane	76-11-9	500	4,170	625	5,210	-	-	-
1,1,2,2-Tetrachloro- 1,2-difluoroethane	76-12-0	500	4,170	625	5,210	-	-	-
1,1,2,2-Tetrachloro- ethane	79-34-5	1	7	-	-	-	-	X
Tetrachoroethylene		See Perchloroethylene						

TABLE 202-1 Limits for Air Contaminants¹ (Continued)

Substance	CAS No. ^b	Air Contaminant Limits**						Skin Designation
		PEL-TWA*		PEL-STEL ^a		PEL-CEILING		
		ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	
Tetrachloromethane		See Carbon tetrachloride						
Tetrachloronaphthalene	1335-88-2	-	2	-	4	-	-	X
Tetraethyl lead (as Pb)	78-00-2	-	0.075k	-	0.3k	-	-	X
Tetrahydrofuran	109-99-9	200	590	250	735	-	-	-
Tetramethyl lead, (as Pb)	75-74-1	-	0.075k	-	0.5k	-	-	X
Tetramethyl succino- nitrile	3333-52-6	0.5	3	2	9	-	-	X
Tetranitromethane	509-14-8	1	8	-	-	-	-	-
Tetrasodium pyro- phosphate	7722-88-5	-	5	-	-	-	-	-
Tetryl (2,4,6- Trinitrophenyl- methyl-nitramine)	479-45-8	-	1.5	-	-	-	-	X
Thallium, soluble compounds (as Tl)	7440-28-0	-	0.1	-	-	-	-	X
4,4'-Thiobis (6-tert, butyl-m-cresol)	96-69-5							
Total dust		-	10	-	20	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Thioglycolic acid	68-11-1	1	4	-	-	-	-	X
Thionyl chloride	7719-09-7	-	-	-	-	1	5	-
Thiram	137-26-8	-	1	-	-	-	-	-
Tin, inorganic compounds (except oxides) (as Sn)	7440-31-5	-	2	-	4	-	-	-
Tin, organic compounds (as Sn)	7440-31-5	-	0.1	-	0.2	-	-	X
Tin oxide (as Sn)	21651-19-4	-	2	-	4	-	-	-
Titanium dioxide	13463-67-7							
Total dust		-	10	-	20	-	-	-
Toluene (Toluol)	108-88-3	100	375	150	560	-	-	X
Toluene di- isocyanate (TDI)	584-84-9	0.005	0.04	0.02	0.15	-	-	-
m-Toluidine	108-44-1	2	9	-	-	-	-	X
o-Toluidine	95-53-4	5	22	-	-	-	-	X
p-Toluidine	106-49-0	2	9	-	-	-	-	X
Toxaphene		See Chlorinated camphene						
Tremolite		See Silicates						
Tributyl phosphate	126-73-8	0.2	2.5	0.4	5	-	-	-
Trichloroacetic acid	76-03-9	1	5	-	-	-	-	-
1,2,4-Trichlorobenzene	120-82-1	-	-	-	-	5	40	-
1,1,1-Trichloroethane		See Methyl chloroform						

TABLE 202-1 Limits for Air Contaminants¹ (Continued)

Substance	CAS No. ^b	Air Contaminant Limits**						Skin Design- nation
		PEL-TWA*		PEL-STEL ^a		PEL-CEILING		
		ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	
1,1,2-Trichloroethane	79-00-5	10	45	20	90	-	-	X
Trichloroethylene	79-01-6	50	270	200	1,080	-	-	-
Trichloromethane		See Chloroform						
Trichloronaphthalene	1321-65-9	-	5	-	10	-	-	X
1,2,3-Trichloropropane	96-18-4	10	60	75	450	-	-	X
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	1,000	7,600	1,250	9,500	-	-	-
Triethylamine	121-44-8	10	40	15	60	-	-	-
Trifluorobromomethane	75-63-8	1,000	6,100	1,200	7,300	-	-	-
Trimellitic anhydride	552-30-7	0.005	0.04	-	-	-	-	-
Trimethylamine	75-50-3	10	24	15	36	-	-	-
Trimethyl benzene	25551-13-7	25	125	35	170	-	-	-
Trimethyl phosphite	121-45-9	2	10	5	25	-	-	-
2,4,6-Trinitrophenyl		See Picric acid						
2,4,6-Trinitrophenyl-methyl nitramine		See Tetryl						
2,4,6-Trinitrotoluene (TNT)	118-96-7	-	0.5	-	-	-	-	X
Triorthocresyl phosphate	78-30-8	-	0.1	-	-	-	-	X
Triphenyl amine	603-34-9	-	5	-	-	-	-	-
Triphenyl phosphate	115-86-6	-	3	-	6	-	-	X
Tungsten (as W)	7440-33-7							
Insoluble compounds		-	5	-	10	-	-	-
Soluble compounds		-	1	-	3	-	-	-
Turpentine	8006-64-2	100	560	150	840	-	-	-
Uranium (as U)	7440-61-1							
Soluble compounds		-	0.05	-	-	-	-	-
Insoluble compounds		-	0.2	-	0.6	-	-	-
n-Valeraldehyde	110-62-3	50	175	-	-	-	-	-
Vanadium	1314-62-1							
Respirable dust (as V2O5)	-	0.05		-	-	-	-	-
Fume (as V2O5)	-	0.05		-	-	-	-	-
Vegetable oil mist	-							
Total dust	-	10		-	-	-	-	-
Respirable fraction	-	5		-	-	-	-	-
Vinyl acetate	108-05-4	10	30	20	60	-	-	-
Vinyl benzene		See Styrene						
Vinyl bromide	593-60-2	5	20	-	-	-	-	-
Vinyl chloride	75-01-4	See §12-202-28						
Vinylcyanide		See Acrylonitrile						
Vinyl cyclohexene dioxide	106-87-6	10	60	-	-	-	-	X

TABLE 202-1 Limits for Air Contaminants¹ (Continued)

Substance	CAS No. ^b	Air Contaminant Limits**						Skin Designation
		PEL-TWA*		PEL-STEL ^a		PEL-CEILING		
		ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	ppm ^c	mg/m ^{3d}	
Vinylidene chloride (1,1-Dichloro-ethylene)	75-35-4	1	4	-	-	-	-	-
Vinyl toluene	25013-15-4	50	240	100	485	-	-	-
VM & P Naphtha	8032-32-4	300	1,350	400	1,800	-	-	-
Warfarin	81-81-2	-	0.1	-	0.3	-	-	-
Welding fumes (total particulate)	-	-	5	-	-	-	-	-
Wood dust:								
Certain hardwoods as beech & oak	-	-	1	-	-	-	-	-
All soft woods, (except Western red cedar)	-	-	5	-	10	-	-	-
Wood dust, Western red cedar	-	-	2.5	-	-	-	-	-
Xylenes (o-, m-, p- isomers)	1330-20-7	100	435	150	655	-	-	X
m-Xylene •, •'- diamine	1477-55-0	-	-	-	-	-	0.1	X
Xylidine	1300-73-8	0.5	2.5	-	-	-	-	X
Yttrium	7440-65-5	-	1	-	3	-	-	-
Zinc chloride fume	7646-85-7	-	1	-	2	-	-	-
Zinc chromate (as CrO3)	Varies with Compound	-	0.01	-	-	-	0.1	-
Zinc oxide fume	1314-13-2	-	5	-	10	-	-	-
Zinc oxide	1314-13-2							
Total dust		-	10	-	-	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Zinc stearate	557-05-1							
Total dust		-	10	-	20	-	-	-
Respirable fraction		-	5	-	-	-	-	-
Zirconium compounds (as Zr)	7440-67-2	-	5	-	10	-	-	-

Footnotes to Table 202-1:

Air Contaminant Rule Limits are the most restrictive of the federal limits, ACGIH limits and existing DOSH limits.

* The PEL-TWA's are 7- to 8-hour TWA's, unless otherwise noted.

** Unless otherwise noted, employers in General Industry (i.e., those covered by Part 2 of the DOSH standards) may use any combination of controls to achieve these limits, until December 31, 1992.

a. STEL duration is for 15 minutes, unless otherwise noted.

b. The CAS number is for information only. Enforcement is based on the substance name. For an entry covering more than one metal compound measured as the metal, the CAS number for the metal is given--not the CAS numbers for the individual compounds.

c. Ppm are in parts of vapor or gas per million parts of contaminated air by volume at 25°C and 760 torr.

- d. Mg/m³ are approximate milligrams of substance per cubic meter of air.
- e. The final benzene standard in section 12-202-36 applies to all occupational exposures to benzene except some sub segments of industry where exposures are consistently under the action level (e.g., distribution and sale of fuels, sealed containers and pipelines, coke production, oil and gas drilling and production, natural gas processing, and the percentage exclusion for liquid mixtures); for the excepted sub segments, the benzene limits in Table 202-2 apply.
- f. Coal tar pitch volatiles mean the fused polycyclic hydrocarbons that volatilize from the distillation residues of coal, petroleum, (excluding asphalt, CAS 8052-42-4 and CAS 64742-93-4), wood, and other organic matter.
- g. Cotton dust refers to lint-free dust as measured by the vertical elutriator, cotton-dust sampler described in the Transactions of the National Conference on Dust, p. 33 by J.R. Lynch, (May 2, 1970). The PEL-TWA in the table applies to respirable dust as measured by a vertical elutriator cotton dust sampler or equivalent instrument. The time-weighted average applies to the cotton waste processing operations of waste cycling (sorting, blending, cleaning, and willowing) and garreting. See also section 12-202-32.
- h. Fibrous glass dust means particles <7µm in diameter.
- i. Oil mist as sampled by a method that does not collect vapor.
- j. Compliance with the Subtilisins PEL-TWA is assessed by sampling with a high volume sampler (600-800 liters per minute) for at least 60 minutes.
- k. For control of tetraethyl lead and tetramethyl lead in general room air, biologic monitoring is essential for personnel monitoring.
- l. Most Occupational exposures to EGDN actually involve mixtures of EGDN and nitroglycerin (NG). This EGDN:NG mixture has a PEL-STEEL of 0.1 mg/m³.

TABLE 202-2

Material	Industry Segments	Skin Designation	8-hour time-weighted average	Ceiling concentration
Benzene	(Z37.40-1969) ¹	-	10 ppm	25 ppm
Beryllium and Beryllium Compounds	(Z37.29-1970)	-	2 µg/m ³	5 µg/m ³
Ethylene Dibromide	(Z37.31-1970)	X	20 ppm	30 ppm
Methyl chloride	(Z37.18-1969)	-	100 ppm	200 ppm

¹This standard applies to the industry segments exempt from the 1 ppm 8-hour TWA and 5 ppm STEL of the benzene standard at section 12-202-36. This standard also applies to any industry for which section 12-202-36 is stayed or otherwise not in effect. [Eff 3/22/91; am 6/8/92; am 5/2/97; am 4/11/98] (Auth: HRS §396-4) (Imp: HRS §396-4)

§12-202-6 Exposure for more than 8 hours. (a) The permissible exposure limit to hazardous substances described or listed in this chapter for shifts greater than 8 hours shall be the PEL for greater-than-8-hour exposure. (b) This formula shall be used to compute the TWA for greater-than-8-hour exposure:

$$\text{TWA} = \text{ppm-hours} / \text{total hours exposed}.$$

For example, suppose an employee was exposed to 9.3 ppm-hours of chlorine over a 10-hour span. Then:

$$\text{TWA} = 9.3 \text{ ppm-hours} / 10.0 \text{ hours} = 0.93 \text{ ppm}.$$

However, this TWA cannot be compared to the PEL-TWA in table 202-1 to determine whether the PEL-TWA has been exceeded.

(c) A substance greater-than-8-hours-exposure PEL shall be computed from the following general formula:

$$\text{substance } >8 \text{ hour PEL} = \text{maximum concentration-hours} / \text{total hours exposure}.$$

- (1) Since the maximum concentration-hours (in either ppm-hours or mg/m³-hours) is calculated from the appropriate substance PEL-TWA of table 202-1 multiplied by 8 hours, the above formula is equivalent to the following formula:

$$\text{substance } >8 \text{ hour PEL} = \text{PEL-TWA (table 202-1)} \times 8 \text{ hours} / \text{total hours exposure}.$$

- (2) In the chlorine example above, therefore, where the chlorine PEL-TWA in table 202-1 is 0.5 ppm, the chlorine 10-hour exposure PEL is calculated in ppm as follows:

chlorine 10-hour PEL = 0.5 ppm x 8 hours/10.0 hours
 = ppm-hours/10.0 hours
 = 0.4 ppm;

similarly, for example, note that (in ppm) the:
 chlorine 12-hour PEL = 0.33 ppm; and
 chlorine 20-hour PEL = 0.2 ppm.

The chlorine 10-hour TWA (i.e., 0.93 ppm, computed in subsection (b) above) is greater than the chlorine 10-hour PEL of 0.4 ppm; therefore, the employee was exposed to an unacceptable level of chlorine. [Eff. 7/12/82; am 6/16/84; am 3/22/91]
 (Auth: HRS §396-4) (Imp: HRS §396-4)

§12-202-12 Achieving compliance. To achieve compliance within the limits prescribed in this chapter, administrative or engineering controls must first be determined and implemented whenever feasible. When those controls are not feasible to achieve full compliance, protective equipment or any other protective measures shall be used to keep the exposure of employees to air contaminants within the limits prescribed in this chapter. Any equipment and technical measure used for this purpose must be approved for each particular use by a competent industrial hygienist or another technically qualified person. Whenever respirators are used, their use shall comply with chapter 12-64. [Eff. 7/12/82]
 (Auth: HRS §396-4) (Imp: HRS §396-4)

§12-202-14.1 13 Carcinogens (4- Nitrobiphenyl, etc). (a)
 Incorporation of federal standard. Title 29, Code of Federal Regulations, section 1910.1003, entitled "13 Carcinogens (4- Nitrobiphenyl, etc)", published by the Office of the Federal Register, National Archives and Records Administration on March 7, 1996, and the amendments published on June 20, 1996; January 8, 1998; April 23, 1998; and January 5, 2005, are made a part of this section, except as provided in subsection (b).

(b) Definitions. As used in 29 CFR section 1910.1003 and applied to this section:

"§1910.20" means section 12-202-3.

"§1910.134" means section 12-64.1-2.

"§1910.141" means chapter 12-67.

"OSHA Area Director" means the director of the department of labor and industrial relations or the director's designee." [Eff 11/16/96; am 2/8/97; am 7/6/98; am 3/31/06] (Auth: HRS §396-4) (Imp: HRS §396-4)

§1910.1003 13 Carcinogens (4-Nitrobiphenyl, etc).

(a) Scope and application.

- (1) This section applies to any area in which the 13 carcinogens addressed by this section are manufactured, processed, repackaged, released, handled, or stored, but shall not apply to transshipment in sealed containers, except for the labeling requirements under paragraphs (e)(2), (3) and (4) of this section. The 13 carcinogens are the following:

4-Nitrobiphenyl, Chemical Abstracts Service Register Number (CAS No.) 92933;
 alpha-Naphthylamine, CAS 134327;
 methyl chloromethyl ether, CAS No. 107302;
 3,3'-Dichlorobenzidine (and its salts) CAS No. 91941;
 bis-Chloromethyl ether, CAS No. 542881;
 beta-Naphthylamine, CAS No. 91598;
 Benzidine, CAS No. 92875;
 4-Aminodiphenyl, CAS No. 92671;
 Ethyleneimine, CAS No. 151564;
 beta-Propiolactone, CAS No. 57578;
 2-Acetylaminofluorene, CAS No. 53963;
 4-Dimethylaminoazo-benzene, CAS No. 60117; and
 N-Nitrosodimethylamine, CAS No. 62759.

- (2) This section shall not apply to the following:
- (i) Solid or liquid mixtures containing less than 0.1 percent by weight or volume of 4-Nitrobiphenyl; methyl chloromethyl ether; bis-chloromethyl ether; beta-Naphthylamine; benzidine or 4-Aminodiphenyl; and
 - (ii) Solid or liquid mixtures containing less than 1.0 percent by weight or volume of alpha-Naphthylamine; 3,3'-Dichlorobenzidine (and its salts); Ethyleneimine; beta-Propiolactone; 2-Acetylaminofluorene; 4-Dimethylaminoazobenzene, or N-Nitrosodimethylamine.
- (b) Definitions. For the purposes of this section:
- Absolute filter** is one capable of retaining 99.97 percent of a mono disperse aerosol of 0.3 µm particles.
- Authorized employee** means an employee whose duties require him to be in the regulated area and who has been specifically assigned by the employer.
- Clean change room** means a room where employees put on clean clothing and/or protective equipment in an environment free of the 13 carcinogens addressed by this section. The clean change room shall be contiguous to and have any entry from a shower room, when the shower room facilities are otherwise required in this section.
- Closed system** means an operation involving a carcinogen addressed by this section where containment prevents the release of the material into regulated areas, non-regulated areas, or the external environment.
- Decontamination** means the inactivation of a carcinogen addressed by this section or its safe disposal.
- Director** means the Director, National Institute for Occupational Safety and Health, or any person directed by him or the Secretary of Health and Human Services to act for the Director.
- Disposal** means the safe removal of the carcinogens addressed by this section from the work environment.
- Emergency** means an unforeseen circumstance or set of circumstances resulting in the release of a carcinogen addressed by this section that may result in exposure in or contact with the material.
- External environment** means any environment external to regulated and non-regulated areas.
- Isolated system** means a fully enclosed structure other than the vessel of containment of a carcinogen addressed by this section that is impervious to the passage of the material and would prevent the entry of the carcinogen addressed by this section into regulated areas, non-regulated areas, or the external environment, should leakage or spillage from the vessel of containment occur.
- Laboratory-type hood** is a device enclosed on the three sides and the top and bottom, designed and maintained so as to draw air inward at an average linear face velocity of 150 feet per minute with a minimum of 125 feet per minute; designed, constructed, and maintained in such a way that an operation involving a carcinogen addressed by this section within the hood does not require the insertion of any portion of any employee's body other than his hands and arms.
- Non-regulated area** means any area under the control of the employer where entry and exit is neither restricted nor controlled.
- Open-vessel system** means an operation involving a carcinogen addressed by this section in an open vessel that is not in an isolated system, a laboratory-type hood, nor in any other system affording equivalent protection against the entry of the material into regulated areas, non-regulated areas, or the external environment.
- Protective clothing** means clothing designed to protect an employee against contact with or exposure to a carcinogen addressed by this section.
- Regulated area** means an area where entry and exit is restricted and controlled.
- (c) Requirements for areas containing a carcinogen addressed by this section. A regulated area shall be established by an employer where a carcinogen addressed by this section is manufactured, processed, used, repackaged, released, handled or stored. All such areas shall be controlled in accordance with the requirements for the following category or categories describing the operation involved:
- (1) Isolated systems. Employees working with a carcinogen addressed by this section within an isolated system such as a "glove box" shall wash their hands and arms upon completion of the assigned task and before engaging in other activities not associated with the isolated system.
 - (2) Closed system operation.
 - (i) Within regulated areas where the carcinogens addressed by this section are stored in sealed containers, or contained in a closed system, including piping systems, with any

- sample ports or openings closed while the carcinogens addressed by this section are contained within, access shall be restricted to authorized employees only.
- (ii) Employees exposed to 4-Nitrobiphenyl; alpha-Naphthylamine; 3,3'-Dichlorobenzidine (and its salts); beta-Naphthylamine; benzidine; 4-Aminodiphenyl; 2-Acetylamino-fluorene; 4-Dimethylaminoazo-benzene; and N-Nitrosodimethylamine shall be required to wash hands, forearms, face, and neck upon each exit from the regulated areas, close to the point of exit, and before engaging in other activities.
 - (3) Open-vessel system operations. Open-vessel system operations as defined in paragraph (b)(13) of this section are prohibited.
 - (4) Transfer from a closed system, charging or discharging point operations, or otherwise opening a closed system. In operations involving "laboratory-type hoods," or in locations where the carcinogens addressed by this section are contained in an otherwise "closed system," but is transferred, charged, or discharged into other normally closed containers, the provisions of this paragraph shall apply.
 - (i) Access shall be restricted to authorized employees only.
 - (ii) Each operation shall be provided with continuous local exhaust ventilation so that air movement is always from ordinary work areas to the operation. Exhaust air shall not be discharged to regulated areas, non-regulated areas or the external environment unless decontaminated. Clean make-up air shall be introduced in sufficient volume to maintain the correct operation of the local exhaust system.
 - (iii) Employees shall be provided with, and required to wear, clean, full body protective clothing (smocks, coveralls, or long-sleeved shirt and pants), shoe covers and gloves prior to entering the regulated area.
 - (iv) Employees engaged in handling operations involving the carcinogens addressed by this section must be provided with, and required to wear and use, a half-face, filter-type respirator with filters for dusts, mists, and fumes, or air-purifying canisters or cartridges. A respirator affording higher levels of protection may be substituted.
 - (v) Prior to each exit from a regulated area, employees shall be required to remove and leave protective clothing and equipment at the point of exit and at the last exit of the day, to place used clothing and equipment in impervious containers at the point of exit for purposes of decontamination or disposal. The contents of such impervious containers shall be identified, as required under paragraphs (e)(2), (3), and (4) of this section.
 - (vi) Drinking fountains are prohibited in the regulated area.
 - (vii) Employees shall be required to wash hands, forearms, face, and neck on each exit from the regulated area, close to the point of exit, and before engaging in other activities and employees exposed to 4-Nitrobiphenyl; alpha-Naphthylamine; 3,3'-Dichlorobenzidine (and its salts); beta-Naphthylamine; Benzidine; 4-Aminodiphenyl; 2-Acetylamino-fluorene; 4-Dimethylaminoazo-benzene; and N-Nitrosodimethylamine shall be required to shower after the last exit of the day.
 - (5) Maintenance and decontamination activities. In cleanup of leaks of spills, maintenance, or repair operations on contaminated systems or equipment, or any operations involving work in an area where direct contact with a carcinogen addressed by this section could result, each authorized employee entering that area shall:
 - (i) Be provided with and required to wear clean, impervious garments, including gloves, boots, and continuous-air supplied hood in accordance with §1910.134;
 - (ii) Be decontaminated before removing the protective garments and hood;
 - (iii) Be required to shower upon removing the protective garments and hood.
- (d) General regulated area requirements.**
- (1) Respirator program. The employer must implement a respiratory protection program in accordance with 29 CFR 1910.134(b), (c), (d) (except (d)(1)(iii) and (iv), and (d)(3), and (e) through (m).
 - (2) Emergencies. In an emergency, immediate measures including, but not limited to, the requirements of paragraphs (d)(2)(i) through (v) of this section shall be implemented.
 - (i) The potentially affected area shall be evacuated as soon as the emergency has been determined.
 - (ii) Hazardous conditions created by the emergency shall be eliminated and the potentially affected area shall be decontaminated prior to the resumption of normal operations.
 - (iii) Special medical surveillance by a physician shall be instituted within 24 hours for employees present in the potentially affected area at the time of the emergency. A report

- of the medical surveillance and any treatment shall be included in the incident report, in accordance with paragraph (f)(2) of this section.
- (iv) Where an employee has a known contact with a carcinogen addressed by this section, such employee shall be required to shower as soon as possible, unless contraindicated by physical injuries.
 - (v) An incident report on the emergency shall be reported as provided in paragraph (f)(2) of this section.
 - (vi) Emergency deluge showers and eyewash fountains supplied with running potable water shall be located near, within sight of, and on the same level with locations where a direct exposure to Ethyleneimine or beta-Propiolactone only would be most likely as a result of equipment failure or improper work practice.
- (3) Hygiene facilities and practices.
- (i) Storage or consumption of food, storage or use of containers of beverages, storage or application of cosmetics, smoking, storage of smoking materials, tobacco products or other products for chewing, or the chewing of such products are prohibited in regulated areas.
 - (ii) Where employees are required by this section to wash, washing facilities shall be provided in accordance with §1910.141(d)(1) and (2)(ii) through (vii).
 - (iii) Where employees are required by this section to shower, shower facilities shall be provided in accordance with §1910.141(d)(3).
 - (iv) Where employees wear protective clothing and equipment, clean change rooms shall be provided for the number of such employees required to change clothes, in accordance with §1910.141(e).
 - (v) Where toilets are in regulated areas, such toilets shall be in a separate room.
- (4) Contamination control.
- (i) Except for outdoor systems, regulated areas shall be maintained under pressure negative with respect to non-regulated areas. Local exhaust ventilation may be used to satisfy this requirement. Clean makeup air in equal volume shall replace air removed.
 - (ii) Any equipment, material, or other item taken into or removed from a regulated area shall be done so in a manner that does not cause contamination in non-regulated areas or the external environment.
 - (iii) Decontamination procedures shall be established and implemented to remove carcinogens addressed by this section from the surfaces of materials, equipment, and the decontamination facility.
 - (iv) Dry sweeping and dry mopping are prohibited for 4-Nitrobiphenyl; alpha-Naphthylamine; 3,3'-Dichlorobenzidine (and its salts); beta-Naphthylamine; Benzidine; 4-Aminodiphenyl; 2-Acetylaminofluorene; 4-Dimethylaminoazo-benzene; and N-Nitrosodimethylamine.
- (e) Signs, information and training.
- (1) Signs.
- (i) Entrances to regulated areas shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT

AUTHORIZED PERSONNEL ONLY
 - (ii) Entrances to regulated areas containing operations covered in paragraph (c)(5) of this section shall be posted with signs bearing the legend:

CANCER-SUSPECT AGENT EXPOSED IN THIS AREA

IMPERVIOUS SUIT INCLUDING GLOVES, BOOTS,
AND AIR-SUPPLIED HOOD REQUIRED AT ALL TIMES

AUTHORIZED PERSONNEL ONLY
 - (iii) Appropriate signs and instructions shall be posted at the entrance to, and exit from, regulated areas, informing employees of the procedures that must be followed in entering and leaving a regulated area.
- (2) Container contents identification.

- (i) Containers of a carcinogen addressed by this section and containers required under paragraphs (c)(4)(v) and (c)(6)(vii)(B) and (viii)(B) of this section that are accessible only to and handled only by authorized employees, or by other employees trained in accordance with paragraph (e)(5) of this section, may have contents identification limited to a generic or proprietary name or other proprietary identification of the carcinogen and percent.
- (ii) Containers of a carcinogen addressed by this section and containers required under paragraphs (c)(4)(v) and (c)(6)(vii)(B), and (viii)(B) of this section that are accessible to or handled by employees other than authorized employees or employees trained in accordance with paragraph (e)(5) of this section shall have contents identification that includes the full chemical name and Chemical Abstracts Service Registry number as listed in paragraph (a)(1) of this section.
- (iii) Containers shall have the warning words "CANCER-SUSPECT AGENT" displayed immediately under or adjacent to the contents identification.
- (iv) Containers whose contents are carcinogens addressed by this section with corrosive or irritating properties shall have label statements warning of such hazards noting, if appropriate, particularly sensitive or affected portions of the body.
- (3) Lettering. Lettering on signs and instructions required by paragraph (e)(1) of this section shall be a minimum letter height of 2 inches (5 cm). Labels on containers required under this section shall not be less than one half the size of the largest lettering on the package, and not less than 8-point type in any instance. Provided, that no such required lettering need be more than 1 inch (2.5 cm) in height.
- (4) Prohibited statements. No statement shall appear on or near any required sign, label, or instruction that contradicts or detracts from the effect of any required warning, information, or instruction.
- (5) Training and indoctrination.
 - (i) Each employee prior to being authorized to enter a regulated area, shall receive a training and indoctrination program including, but not necessarily limited to:
 - (A) The nature of the carcinogenic hazards of a carcinogen addressed by this section, including local and systemic toxicity;
 - (B) The specific nature of the operation involving a carcinogen addressed by this section that could result in exposure;
 - (C) The purpose for and application of the medical surveillance program, including, as appropriate, methods of self-examination;
 - (D) The purpose for and application of decontamination practices and purposes;
 - (E) The purpose for and significance of emergency practices and procedures;
 - (F) The employee's specific role in emergency procedures;
 - (G) Specific information to aid the employee in recognition and evaluation of conditions and situations that may result in the release of carcinogen addressed by this section;
 - (H) The purpose for and application of specific first aid procedures and practices;
 - (I) A review of this section at the employee's first training and indoctrination program and annually thereafter.
 - (ii) Specific emergency procedures shall be prescribed, and posted, and employees shall be familiarized with their terms, and rehearsed in their application.
 - (iii) All materials relating to the program shall be provided upon request to authorized representatives of the Assistant Secretary and the Director.
- (f) [Reserved]
- (g) Medical surveillance. At no cost to the employee, a program of medical surveillance shall be established and implemented for employees considered for assignment to enter regulated areas, and for authorized employees.
 - (1) Examinations.
 - (i) Before an employee is assigned to enter a regulated area, a pre-assignment physical examination by a physician shall be provided. The examination shall include the personal history of the employee, family and occupational background, including genetic and environmental factors.
 - (ii) Authorized employees shall be provided periodic physical examinations, not less often than annually, following the pre-assignment examination.

- (iii) In all physical examinations, the examining physician shall consider whether there exist conditions of increased risk, including reduced immunological competence, those undergoing treatment with steroids or cytotoxic agents, pregnancy, and cigarette smoking.
- (2) Records.
 - (i) Employers of employees examined pursuant to this paragraph shall cause to be maintained complete and accurate records of all such medical examinations. Records shall be maintained for the duration of the employee's employment. Upon termination of the employee's employment, including retirement or death, or the event that the employer ceases business without a successor, records, or notarized true copies thereof, shall be forwarded by registered mail to the Director.
 - (ii) Records required by this paragraph shall be provided upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.20(a) through (e) and (g) through (i). These records shall also be provided upon request to the Director.
 - (iii) Any physician who conducts a medical examination required by this paragraph shall furnish to the employer a statement of the employee's suitability for employment in the specific exposure.

(b) Definitions. As used in 29 CFR section 1910.1003 and applied to this section:

"§1910.20" means §12-202-3.

"§1910.134" means §12-64.1-2.

"§1910.141" means chapter 12-67.

"OSHA Area Director" means the director of the department of labor and industrial relations or the director's designee. [Eff 11/16/96; am 2/8/97; am 7/6/98] (Auth: HRS §396-4) (Imp: HRS §396-4)

§12-202-28.1 Vinyl Chloride. (a) Incorporation of federal standard. Title 29, Code of Federal Regulations, section 1910.1017, entitled "Vinyl Chloride" published by the Office of the Federal Register, National Archives and Records Administration on October 4, 1974; and the amendments published on December 3, 1974; March 25, 1975; Redesignated May 28, 1975; Amendments October 24, 1975; May 23, 1980; June 7, 1989; June 30, 1993; February 13, 1996; January 8, 1998; June 18, 1998; and January 5, 2005, are made a part of this section, except as provided in subsection (b).

(b) Definitions. As used in 29 CFR section 1910.1017 and applied to this section:

"§1910.20" means section 1910.20 in section 12-202-3. [Eff 7/6/98; am 3/29/1999; am 3/31/06] (Auth: HRS §396-4) (Imp: HRS §396-4)

Historical note: §12-202-28.1 is based substantially upon section 12-202-28. [Eff 7/12/82; R 7/6/98]

§1910.1017 Vinyl chloride.

(a) Scope and application.

- (1) This section includes requirements for the control of employee exposure to vinyl chloride (chloroethene), Chemical Abstracts Service Registry No. 75014.
- (2) This section applies to the manufacture, reaction, packaging, repackaging, storage, handling or use of vinyl chloride or polyvinyl chloride, but does not apply to the handling or use of fabricated products made of polyvinyl chloride.
- (3) This section applies to the transportation of vinyl chloride or polyvinyl chloride except to the extent that the Department of Transportation may regulate the hazards covered by this section.

(b) Definitions.

Action level means a concentration of vinyl chloride of 0.5 ppm averaged over an 8-hour workday.

Assistant Secretary means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or his designee.

Authorized person means any person specifically authorized by the employer whose duties require him to enter a regulated area or any person entering such an area as a designated representative of employees for the purpose of exercising an opportunity to observe monitoring and measuring procedures

Director means the Director, National Institute for Occupational Safety and Health, U.S. Department of Health and Human Services, or his designee.

Emergency means any occurrence such as, but not limited to, equipment failure, or operation of a relief device that is likely to, or does, result in massive release of vinyl chloride.

Fabricated product means a product made wholly or partly from polyvinyl chloride, and which does not require further processing at temperatures, and for times, sufficient to cause mass melting of the polyvinyl chloride resulting in the release of vinyl chloride.

Hazardous operation means any operation, procedure, or activity where a release of either vinyl chloride liquid or gas might be expected as a consequence of the operation or because of an accident in the operation, which would result in an employee exposure in excess of the permissible exposure limit.

OSHA Area Director means the Director for the Occupational Safety and Health Administration Area Office having jurisdiction over the geographic area in which the employer's establishment is located.

Polyvinyl chloride means polyvinyl chloride homopolymer or copolymer before such is converted to a fabricated product.

Vinyl chloride means vinyl chloride monomer.

(c) Permissible exposure limit.

- (1) No employee may be exposed to vinyl chloride at concentrations greater than 1 ppm averaged over any 8-hour period, and
- (2) No employee may be exposed to vinyl chloride at concentrations greater than 5 ppm averaged over any period not exceeding 15 minutes.
- (3) No employee may be exposed to vinyl chloride by direct contact with liquid vinyl chloride.

(d) Monitoring.

- (1) A program of initial monitoring and measurement shall be undertaken in each establishment to determine if there is any employee exposed, without regard to the use of respirators, in excess of the action level.
- (2) Where a determination conducted under paragraph (d)(1) of this section shows any employee exposures, without regard to the use of respirators, in excess of the action level, a program for determining exposures for each such employee shall be established. Such a program:
 - (i) Must be repeated at least quarterly for any employee exposed, without regard to the use of respirators, in excess of the permissible exposure limit.
 - (ii) must be repeated not less than every six months for any employee exposed without regard to the use of respirators, at or above the action level.
 - (iii) May be discontinued for any employee only when at least two consecutive monitoring determinations, made not less than 5 working days apart, show exposures for that employee at or below the action level.
- (3) Whenever there has been a production, process or control change that may result in an increase in the release of vinyl chloride, or the employer has any other reason to suspect that any employee may be exposed in excess of the action level, a determination of employee exposure under paragraph (d)(1) of this section shall be performed.
- (4) The method of monitoring and measurement shall have an accuracy (with a confidence level of 95 percent) of not less than plus or minus 50 percent from 0.25 through 0.5 ppm, plus or minus 35 percent from over 0.5 ppm through 1.0 ppm, and plus or minus 25 percent over 1.0 ppm. (Methods meeting these accuracy requirements are available in the "NIOSH Manual of Analytical Methods").
- (5) Employees or their designated representatives shall be afforded reasonable opportunity to observe the monitoring and measuring required by this paragraph.

(e) Regulated area.

- (1) A regulated area shall be established where:
 - (i) Vinyl chloride or polyvinyl chloride is manufactured, reacted, repackaged, stored, handled or used; and
 - (ii) Vinyl chloride concentrations are in excess of the permissible exposure limit.
- (2) Access to regulated areas shall be limited to authorized persons

(f) Methods of compliance. Employee exposures to vinyl chloride shall be controlled to at or below the

permissible exposure limit provided in paragraph (c) of this section by engineering, work practice, and personal protective controls as follows:

- (1) Feasible engineering and work practice controls shall immediately be used to reduce exposures to at or below the permissible exposure limit.
- (2) Wherever feasible engineering and work practice controls which can be instituted immediately are not sufficient to reduce exposures to at or below the permissible exposure limit, they shall nonetheless be used to reduce exposures to the lowest practicable level, and shall be supplemented by respiratory protection in accordance with paragraph (g) of this section. A program shall be established and implemented to reduce exposures to at or below the permissible exposure limit, or to the greatest extent feasible, solely by means of engineering and work practice controls, as soon as feasible.
- (3) Written plans for such a program shall be developed and furnished upon request for examination and copying to authorized representatives of the Assistant Secretary and the Director. Such plans must be updated at least annually.

(g) Respiratory protection.

- (1) General. For employees who use respirators required by this section, the employer must provide respirators that comply with the requirements of this paragraph.
- (2) Respirator program. The employer must implement a respiratory protection program in accordance with 29 CFR 1910.134 (b) through (d) (except (d)(1)(iii), and (d)(3)(iii)(B)(1) and (2)), and (f) through (m).
- (3) Respirator selection.
 - (i) Respirators must be selected from the following table:

Atmospheric concentration of vinyl chloride	Required apparatus
(i) Unknown, or above 3,600 p/m.....	Open circuit, self-contained breathing apparatus, pressure demand type, with full facepiece.
(ii) Not over 3,600 p/m.....	(A) Combination type C supplied air respirator, pressure demand type, with full or half facepiece, and auxiliary self-contained air supply; or
(iii) Not over 1,000 p/m.....	(B) Combination type, supplied air respirator continuous flow type, full or half facepiece and auxiliary self-contained air supply.
(iv) Not over 100 p/m.....	Type C. supplied air respirator, continuous flow type, with full or half facepiece, helmet or hood.
(v) Not over 25 p/m.....	(A) Combination type C supplied air respirator demand type, with full facepiece, and auxiliary self-contained air-supply; or
(vi) Not over 10 p/m.....	(B) Open-circuit self contained breathing apparatus with full facepiece, in demand mode; or
	Type (C) supplied air respirator, demand type with full facepiece.
	(A) A powered air-purifying respirator with hood, helmet, full or half facepiece, and a canister which provides a service life of at least 4 hours for concentrations of vinyl chloride up to 25 p/m, or
	(B) Gas mask, front- or back-mounted canister that provides a service life of at least 4 hours for concentrations of vinyl chloride up to 25 p/m.
	(A) Combination type C supplied-air respirator, demand type, with half facepiece and auxiliary self-contained air-supply; or
	(B) Type C supplied-air respirator, demand type with half facepiece; or
	(C) Any chemical cartridge respirator with an

Atmospheric concentration of vinyl chloride	Required apparatus
	organic vapor cartridge which provides a service life of at least 1 hour for concentrations of vinyl chloride up to 10 p/m.

- (ii) When air-purifying respirators are used:
 - (A) Air-purifying canisters or cartridges must be replaced prior to the expiration of their service life or the end of the shift in which they are first used, whichever occurs first.
 - (B) A continuous-monitoring and alarm system must be provided when concentrations of vinyl chloride could reasonably exceed the allowable concentrations for the devices in use. Such a system must be used to alert employees when vinyl chloride concentrations exceed the allowable concentrations for the devices in use.
- (iii) Respirators specified for higher concentrations may be used for lower concentrations.
- (4) Selection of respirators for vinyl chloride shall be as follows:
- (5) Where air-purifying respirators are used:
 - (i) Air-purifying canisters or cartridges shall be replaced prior to the expiration of their service life or the end of the shift in which they are first used, whichever occurs first, and
 - (ii) A continuous monitoring and alarm system shall be provided where concentrations of vinyl chloride could reasonably exceed the allowable concentrations for the devices in use. Such system shall be used to alert employees when vinyl chloride concentrations exceed the allowable concentrations for the devices in use.
- (6) Apparatus prescribed for higher concentrations may be used for any lower concentration.
- (h) Hazardous operations.**
 - (1) Employees engaged in hazardous operations, including entry of vessels to clean polyvinyl chloride residue from vessel walls, shall be provided and required to wear and use;
 - (i) Respiratory protection in accordance with paragraphs (c) and (g) of this section; and
 - (ii) Protective garments to prevent skin contact with liquid vinyl chloride or with polyvinyl chloride residue from vessel walls. The protective garments shall be selected for the operation and its possible exposure conditions.
 - (2) Protective garments shall be provided clean and dry for each use.
- (i) Emergency situations.** A written operational plan for emergency situations shall be developed for each facility storing, handling, or otherwise using vinyl chloride as a liquid or compressed gas. Appropriate portions of the plan shall be implemented in the event of an emergency. The plan shall specifically provide that:
 - (1) Employees engaged in hazardous operations or correcting situations of existing hazardous releases shall be equipped as required in paragraph (h) of this section;
 - (2) Other employees not so equipped shall evacuate the area and not return until conditions are controlled by the methods required in paragraph (f) of this section and the emergency is abated.
- (j) Training.** Each employee engaged in vinyl chloride or polyvinyl chloride operations shall be provided training in a program relating to the hazards of vinyl chloride and precautions for its safe use.
 - (1) The program shall include:
 - (i) The nature of the health hazard from chronic exposure to vinyl chloride including specifically the carcinogenic hazard;
 - (ii) The specific nature of operations that could result in exposure to vinyl chloride in excess of the permissible limit and necessary protective steps;
 - (iii) The purpose for, proper use, and limitations of respiratory protective devices;
 - (iv) The fire hazard and acute toxicity of vinyl chloride, and the necessary protective steps;
 - (v) The purpose for and a description of the monitoring program;
 - (vi) The purpose for, and a description of, the medical surveillance program;
 - (vii) Emergency procedures;
 - (viii) Specific information to aid the employee in recognition of conditions which may result in the release of vinyl chloride; and
 - (ix) A review of this standard at the employee's first training and indoctrination program, and annually thereafter.
 - (2) All materials relating to the program shall be provided upon request to the Assistant Secretary and the Director.

- (k) Medical surveillance. A program of medical surveillance shall be instituted for each employee exposed, without regard to the use of respirators, to vinyl chloride in excess of the action level. The program shall provide each such employee with an opportunity for examinations and tests in accordance with this paragraph. All medical examinations and procedures shall be performed by or under the supervision of a licensed physician, and shall be provided without cost to the employee.
- (1) At the time of initial assignment, or upon institution of medical surveillance;
 - (i) A general physical examination shall be performed, with specific attention to detecting enlargement of liver, spleen or kidneys, or dysfunction in these organs, and for abnormalities in skin, connective tissues and the pulmonary system (See Appendix A).
 - (ii) A medical history shall be taken, including the following topics:
 - (A) Alcohol intake;
 - (B) Past history of hepatitis;
 - (C) Work history and past exposure to potential hepatotoxic agents, including drugs and chemicals;
 - (D) Past history of blood transfusions; and
 - (E) Past history of hospitalizations.
 - (iii) A serum specimen shall be obtained and determinations made of:
 - (A) Total bilirubin;
 - (B) Alkaline phosphatase;
 - (C) Serum glutamic oxalacetic transaminase (SGOT);
 - (D) Serum glutamic pyruvic transaminase (SGPT); and
 - (E) Gamma glutamyl transpeptidase.
 - (2) Examinations must be provided in accordance with this paragraph at least annually.
 - (i) Every 6 months for each employee who has been employed in vinyl chloride or polyvinyl chloride manufacturing for 10 years or longer; and
 - (ii) Annually for all other employees.
 - (3) Each employee exposed to an emergency shall be afforded appropriate medical surveillance.
 - (4) A statement of each employee's suitability for continued exposure to vinyl chloride including use of protective equipment and respirators, shall be obtained from the examining physician promptly after any examination. A copy of the physician's statement shall be provided each employee.
 - (5) If any employee's health would be materially impaired by continued exposure, such employee shall be withdrawn from possible contact with vinyl chloride.
 - (6) Laboratory analyses for all biological specimens included in medical examination shall be performed by accredited laboratories.
 - (7) If the examining physician determines that alternative medical examinations to those required by paragraph (k)(1) of this section will provide at least equal assurance of detecting medical conditions pertinent to the exposure to vinyl chloride, the employer may accept such alternative examinations as meeting the requirements of paragraph (k)(1) of this section, if the employer obtains a statement from the examining physician setting forth the alternative examinations and the rationale for substitution. This statement shall be available upon request for examination and copying to authorized representatives of the Assistant Secretary and the Director.
- (l) Signs and labels.
- (1) Entrances to regulated areas shall be posted with legible signs bearing the legend:

**CANCER-SUSPECT AGENT AREA
AUTHORIZED PERSONNEL ONLY**

- (2) Areas containing hazardous operations or where an emergency currently exists shall be posted with legible signs bearing the legend:

**CANCER-SUSPECT AGENT IN THIS AREA
PROTECTIVE EQUIPMENT REQUIRED
AUTHORIZED PERSONNEL ONLY**

- (3) Containers of polyvinyl chloride resin waste from reactors or other waste contaminated with vinyl chloride shall be legibly labeled:

**CONTAMINATED WITH VINYL CHLORIDE
CANCER-SUSPECT AGENT**

- (4) Containers of polyvinyl chloride shall be legibly labeled:

POLYVINYL CHLORIDE (OR TRADE NAME)

Contains

VINYL CHLORIDE

VINYL CHLORIDE IS A CANCER-SUSPECT AGENT

- (5) Containers of vinyl chloride shall be legibly labeled either:
(i)

VINYL CHLORIDE

EXTREMELY FLAMMABLE GAS UNDER PRESSURE

CANCER SUSPECT AGENT

or,

- (ii) In accordance with 49 CFR Parts 170 through 189, with the additional legend:

CANCER-SUSPECT AGENT

applied near the label or placard.

- (6) No statement shall appear on or near any required sign, label or instruction that contradicts or detracts from the effect of, any required warning, information or instruction.

(m) Records.

- (1) All records maintained in accordance with this section shall include the name and social security number of each employee where relevant.
- (2) Records of required monitoring and measuring and medical records shall be provided upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.20(a) through (e) and (g) through (i). These records shall be provided upon request to the Director. Authorized personnel rosters shall also be provided upon request to the Assistant Secretary and the Director.
 - (i) Monitoring and measuring records shall:
 - (A) State the date of such monitoring and measuring and the concentrations determined and identify the instruments and methods used;
 - (B) Include any additional information necessary to determine individual employee exposures where such exposures are determined by means other than individual monitoring of employees; and
 - (C) Be maintained for not less than 30 years.
 - (ii) [Reserved]
 - (iii) Medical records shall be maintained for the duration of the employment of each employee plus 20 years, or 30 years, whichever is longer.
- (3) In the event that the employer ceases to do business and there is no successor to receive and retain his records for the prescribed period, these records shall be transmitted by registered mail to the Director, and each employee individually notified in writing of this transfer. The employer shall also comply with any additional requirements set forth in 29 CFR 1910.20(h).

(n) Reports.

- (1) Not later than 1 month after the establishment of a regulated area, the following information

shall be reported to the OSHA Area Director. Any changes to such information shall be reported within 15 days.

- (i) The address and location of each establishment which has one or more regulated areas; and
 - (ii) The number of employees in each regulated area during normal operations, including maintenance.
- (2) Emergencies, and the facts obtainable at that time, shall be reported within 24 hours to the OSHA Area Director. Upon request of the Area Director, the employer shall submit additional information in writing relevant to the nature and extent of employee exposures and measures taken to prevent future emergencies of similar nature.
- (3) Employee notification of monitoring results. The employer must, within 15 working days after receipt of the results of any monitoring performed under this section, notify each affected employee of these results and the steps being taken to reduce exposures within the permissible exposure limit either individually in writing or by posting the results in an appropriate location that is accessible to affected employees.
- (o) Effective dates.
- (1) Until April 1, 1975, the provisions currently set forth in §1910.93q of this part shall apply.
 - (2) Effective April 1, 1975, the provisions set forth in §1910.93q of this part shall apply.

APPENDIX A to §1910.1017 - SUPPLEMENTARY MEDICAL INFORMATION

When required tests under paragraph (k)(1) of this section show abnormalities, the tests should be repeated as soon as practicable, preferably within 3 to 4 weeks. If tests remain abnormal, consideration should be given to withdrawal of the employee from contact with vinyl chloride, while a more comprehensive examination is made.

- A. For kidney dysfunction: urine examination for albumin, red blood cells, and exfoliative abnormal cells.
- B. Pulmonary system: Forced vital capacity, Forced expiratory volume at 1 second, and chest roentgenogram (posterior-anterior, 14 x 17 inches).
- C. Additional serum tests: Lactic acid dehydrogenase, lactic acid dehydrogenase (isoenzyme, protein determination, and protein electrophoresis.
- D. For a more comprehensive examination on repeated abnormal serum tests: Hepatitis B antigen, and liver scanning.

(b) Definitions. As used in 29 CFR section 1910.1017 and applied to this section:

"§1910.20" means section 1910.20 in section 12-202-3. [Eff 7/6/98; am 3/29/99] (Auth: HRS §396-4) (Imp: HRS §396-4)

Historical note: §12-202-28.1 is based substantially upon section 12-202-28. [Eff 7/12/82; R 7/6/98]

§12-202-29.1 1,2-Dibromo-3-Chloropropane. (a) Incorporation of federal standard. Title 29 Code of Federal Regulations, section 1910.1044, entitled "1,2-Dibromo-3-Chloropropane" published by the Office of the Federal Register, National Archives and Records Administration on March 17, 1978 and the amendments published on May 23, 1980; April 30, 1984; June 7, 1989; June 30, 1993; February 13, 1996; January 8, 1998; and January 5, 2005, are made a part of this section, except as provided in subsection (b).

§1910.1044 1,2-dibromo-3-chloropropane.

- (a) Scope and application.
- (1) This section applies to occupational exposure to 1,2-dibromo-3-chloropropane (DBCP).
 - (2) This section does not apply to:
 - (i) Exposure to DBCP which results solely from the application and use of DBCP as a pesticide; or
 - (ii) The storage, transportation, distribution or sale of DBCP in intact containers sealed in

such a manner as to prevent exposure to DBCP vapors or liquid, except for the requirements of paragraphs (i), (n) and (o) of this section.

(b) Definitions.

Authorized person means any person required by his duties to be present in regulated areas and authorized to do so by his employer, by this section, or by the Act.

Authorized person also includes any person entering such areas as a designated representative of employees exercising an opportunity to observe employee exposure monitoring.

DBCP means 1,2-dibromo-3-chloropropane, Chemical Abstracts Service Registry Number 96-12-8, and includes all forms of DBCP.

Director means the Director, National Institute for Occupational Safety and Health, U.S. Department of Health, Education and Welfare, or designee.

Emergency means any occurrence such as, but not limited to equipment failure, rupture of containers, or failure of control equipment that may, or does, result in an unexpected release of DBCP.

OSHA Area Office means the Area Office of the Occupational Safety and Health Administration having jurisdiction over the geographic area where the affected workplace is located.

Assistant Secretary means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

(c) Permissible exposure limit.

- (1) Inhalation. The employer shall assure that no employee is exposed to an airborne concentration of DBCP in excess of 1 part DBCP per billion parts of air (ppb) as an 8-hour time-weighted average.
- (2) Dermal and eye exposure. The employer shall assure that no employee is exposed to eye or skin contact with DBCP.

(d) Notification of use. Within ten (10) days following the introduction of DBCP into the workplace, every employer who has a workplace where DBCP is present, shall report the following information to the nearest OSHA Area Office for each such workplace;

- (1) The address and location of the workplace;
- (2) A brief description of each process or operation that may result in employee exposure to DBCP;
- (3) The number of employees engaged in each process or operation who may be exposed to DBCP and an estimate of the frequency and degree of exposure that occurs; and
- (4) A brief description of the employer's safety and health program as it relates to limitation of employee exposure to DBCP.

(e) Regulated areas.

- (1) The employer shall establish, within each place of employment, regulated areas wherever DBCP concentrations are in excess of the permissible exposure limit.
- (2) The employer shall limit access to regulated areas to authorized persons.

(f) Exposure monitoring.

- (1) General.
 - (i) Determinations of airborne exposure levels shall be made from air samples that are representative of each employee's exposure to DBCP over an 8-hour period.
 - (ii) For the purposes of this paragraph, employee exposure is that exposure which would occur if the employee were not using a respirator.
- (2) Initial. Each employer who has a place of employment in which DBCP is present, shall monitor each workplace and work operation to accurately determine the airborne concentrations of DBCP to which employees may be exposed.
- (3) Frequency.
 - (i) If the monitoring required by this section reveals employee exposures to be at or below the permissible exposure limit, the employer shall repeat these measurements at least every 6 months.
 - (ii) If the monitoring required by this section reveals employee exposures to be in excess of the permissible exposure limit, the employer must repeat these measurements for each such employee at least quarterly. The employer must continue quarterly monitoring until at least two consecutive measurements, taken at least seven (7) days apart, are at or below the permissible exposure limit. Thereafter the employer must monitor at least every 6 months.
- (4) Additional. Whenever there has been a production, process, control, or personnel change that

may result in any new or additional exposure to DBCP, or whenever the employer has any reason to suspect new or additional exposures to DBCP, the employer shall monitor the employees potentially affected by such change for the purpose of redetermining their exposure.

- (5) Employee notification.
 - (i) The employer must, within 15 working days after the receipt of the results of any monitoring performed under this section, notify each employee of these results either individually in writing or by posting the results in an appropriate location that is accessible to employees.
 - (ii) Whenever the results indicate that employee exposure exceeds the permissible exposure limit, the employer shall include in the written notice a statement that the permissible exposure limit was exceeded and a description of the corrective action being taken to reduce exposure to or below the permissible exposure limit.
- (6) Accuracy of measurement. The employer shall use a method of measurement which has an accuracy, to a confidence level of 95 percent, of not less than plus or minus 25 percent for concentrations of DBCP at or above the permissible exposure limit.
- (g) Methods of compliance.
 - (1) Priority of compliance methods. The employer shall institute engineering and work practice controls to reduce and maintain employee exposures to DBCP at or below the permissible exposure limit, except to the extent that the employer establishes that such controls are not feasible. Where feasible engineering and work practice controls are not sufficient to reduce employee exposures to within the permissible exposure limit, the employer shall nonetheless use them to reduce exposures to the lowest level achievable by these controls, and shall supplement them by use of respiratory protection.
 - (2) Compliance program.
 - (i) The employer shall establish and implement a written program to reduce employee exposures to DBCP to or below the permissible exposure limit solely by means of engineering and work practice controls as required by paragraph (g)(1) of this section.
 - (ii) The written program shall include a detailed schedule for development and implementation of the engineering and work practice controls. These plans shall be revised annually to reflect the current status of the program.
 - (iii) Written plans for these compliance programs shall be submitted upon request to the Assistant Secretary and the Director, and shall be available at the worksite for examination and copying by the Assistant Secretary, the Director, and any affected employee or designated representative of employees.
 - (iv) The employer shall institute and maintain at least the controls described in his most recent written compliance program.
- (h) Respiratory protection.
 - (1) General. For employees who are required to use respirators by this section, the employer must provide respirators that comply with the requirements of this paragraph. Respirators must be used during:
 - (i) Periods necessary to install or implement feasible engineering and work-practice controls.
 - (ii) Maintenance and repair activities for which engineering and work-practice controls are not feasible.
 - (iii) Work operations for which feasible engineering and work-practice controls are not yet sufficient to reduce employee exposure to or below the permissible exposure limit.
 - (iv) Emergencies.
 - (2) Respirator program. The employer must implement a respiratory protection program in accordance with 29 CFR 1910.134 (b) through (d) (except (d)(1)(iii)), and (f) through (m).
 - (3) Respirator selection. The employer must select the appropriate respirator from Table 1 of this section.

TABLE 1 - RESPIRATORY PROTECTION FOR DBCP

Airborne concentration of DBCP or condition of use	Respirator Type
(a) Less than or equal to 10 ppb	(1) Any supplied-air respirator; or (2) Any self-contained breathing apparatus.

Airborne concentration of DBCP or condition of use	Respirator Type
(b) Less than or equal to 50 ppb	(1) Any supplied-air respirator with full facepiece, helmet, or hood; or (2) Any self-contained breathing apparatus with full facepiece.
(c) Less than or equal to 1,000 ppb	(1) A Type C supplied-air respirator operated in pressure-demand or other positive pressure or continuous flow mode.
(d) Less than or equal to 2,000 ppb	(1) A Type C supplied-air respirator with full facepiece operated in pressure-demand or other positive pressure mode, or with full facepiece, helmet, or hood operated in continuous flow mode.
(e) Greater than 2,000 ppb or entry and escape from unknown concentrations.	(1) A combination respirator which includes a Type C supplied-air respirator with full facepiece operated in pressure-demand or other positive pressure or continuous flow mode and an auxiliary self-contained breathing apparatus operated in pressure-demand positive pressure mode; or (2) A self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode.
(f) Firefighting	(1) A self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode.

(i) Emergency situations.

- (1) Written plans.
 - (i) A written plan for emergency situations shall be developed for each workplace in which DBCP is present.
 - (ii) Appropriate portions of the plan shall be implemented in the event of an emergency.
- (2) Employees engaged in correcting emergency conditions shall be equipped as required in paragraphs (h) and (j) of this section until the emergency is abated.
- (3) Evacuation. Employees not engaged in correcting the emergency shall be removed and restricted from the area and normal operations in the affected area shall not be resumed until the emergency is abated.
- (4) Alerting employees. Where there is a possibility of employee exposure to DBCP due to the occurrence of an emergency, a general alarm shall be installed and maintained to promptly alert employees of such occurrences.
- (5) Medical surveillance. For any employee exposed to DBCP in an emergency situation, the employer shall provide medical surveillance in accordance with paragraph (m)(6) of this section.
- (6) Exposure monitoring.
 - (i) Following an emergency, the employer shall conduct monitoring that complies with paragraph (f) of this section.
 - (ii) In workplaces not normally subject to periodic monitoring, the employer may terminate monitoring when two consecutive measurements indicate exposures below the permissible exposure limit.

(j) Protective clothing and equipments.

- (1) Provision and use. Where there is any possibility of eye or dermal contact with liquid or solid DBCP, the employer shall provide, at no cost to the employee, and assure that the employee wears impermeable protective clothing and equipment to protect the area of the body that may come in contact with DBCP. Eye and face protection shall meet the requirements of §1910.133 of this part.
- (2) Removal and storage.
 - (i) The employer shall assure that employees remove DBCP contaminated work clothing only in change rooms provided in accordance with paragraph (l)(1) of this section.

- (ii) The employer shall assure that employees promptly remove any protective clothing and equipment that becomes contaminated with DBCP-containing liquids and solids. This clothing shall not be re-worn until the DBCP has been removed from the clothing or equipment.
 - (iii) The employer shall assure that no employee takes DBCP contaminated protective devices and work clothing out of the change room, except those employees authorized to do so for the purpose of laundering, maintenance, of disposal.
 - (iv) DBCP-contaminated protective devices and work clothing shall be placed and stored in closed containers which prevent dispersion of the DBCP outside the container.
 - (v) Containers of DBCP contaminated protective devices or work clothing which are to be taken out of change rooms or the workplace for cleaning, maintenance or disposal, shall bear labels in accordance with paragraph (o)(3) of this section.
- (3) Cleaning and replacement.
 - (i) The employer shall clean, launder, repair, or replace protective clothing and equipment required by this paragraph to maintain their effectiveness. The employer shall provide clean protective clothing and equipment at least daily to each affected employee.
 - (ii) The employer shall inform any person who launders or clean DBCP-contaminated protective clothing or equipment of the potentially harmful effects of exposure to DBCP.
 - (iii) The employer shall prohibit the removal of DBCP from protective clothing and equipment by blowing or shaking.
- (k) House keeping.**
 - (1) Surfaces.
 - (i) All workplace surfaces shall be maintained free of visible accumulations of DBCP.
 - (ii) Dry sweeping and the use of compressed air for the cleaning of floors and other surfaces is prohibited where DBCP dusts or liquids are present.
 - (iii) Where vacuuming methods are selected to clean floors and other surfaces, either portable units or a permanent system may be used.
 - (a) If a portable unit is selected, the exhaust shall be attached to the general workplace exhaust ventilation system or collected within the vacuum unit, equipped with high efficiency filters or other appropriate means of contaminant removal, so that DBCP is not reintroduced into the workplace air; and
 - (b) Portable vacuum units used to collect DBCP may not be used for other cleaning purposes and shall be labeled as prescribed by paragraph (o)(3) of this section.
 - (iv) Cleaning of floors and other surfaces contaminated with DBCP-containing dusts shall not be performed by washing down with a hose, unless a fine spray has first been laid down.
 - (2) Liquids. Where DBCP is present in a liquid form, or as a resultant vapor, all containers or vessels containing DBCP shall be enclosed to the maximum extent feasible and tightly covered when not in use.
 - (3) Waste disposal. DBCP waste scrap, debris, containers or equipment, shall be disposed of in sealed bags or other closed containers which prevent dispersion of DBCP outside the container.
- (l) Hygiene facilities and practices.**
 - (1) Change rooms. The employer shall provide clean change rooms equipped with storage facilities for street clothes and separate storage facilities for protective clothing and equipment whenever employees are required to wear protective clothing and equipment in accordance with paragraphs (h) and (j) of this section.
 - (2) Showers.
 - (i) The employer shall assure that employees working in the regulated area shower at the end of the work shift.
 - (ii) The employer shall assure that employees whose skin becomes contaminated with DBCP-containing liquids or solids immediately wash or shower to remove any DBCP from the skin.
 - (iii) The employer shall provide shower facilities in accordance with 29 CFR 1910.141(d)(3).
 - (3) Lunchrooms. The employer shall provide lunchroom facilities that have a temperature controlled, positive pressure, filtered air supply, and which are readily accessible to employees working in regulated areas.
 - (4) Lavatories.
 - (i) The employer shall assure that employees working in the regulated area remove protective clothing and wash their hands and face prior to eating.

- (ii) The employer shall provide a sufficient number of lavatory facilities which comply with 29 CFR 1910.141(d) (1) and (2).
- (5) Prohibition of activities in regulated areas. The employer shall assure that, in regulated areas, food or beverages are not present or consumed, smoking products and implements are not present or used, and cosmetics are not present or applied.
- (m) Medical surveillance.**
 - (1) General.
 - (i) The employer shall make available a medical surveillance program for employees who work in regulated areas and employees who are subjected to DBCP exposures in an emergency situation.
 - (ii) All medical examinations and procedures shall be performed by or under the supervision of a licensed physician, and shall be provided without cost to the employee.
 - (2) Frequency and content. At the time of initial assignment, and annually thereafter, the employer shall provide a medical examination for employees who work in regulated areas, which includes at least the following:
 - (i) A medical and occupational history including reproductive history.
 - (ii) A physical examination, including examination of the genito-urinary tract, testicle size and body habitus, including a determination of sperm count.
 - (iii) A serum specimen shall be obtained and the following determinations made by radioimmunoassay techniques utilizing National Institutes of Health (NIH) specific antigen or one of equivalent sensitivity:
 - (a) Serum follicle stimulating hormone (FSH);
 - (b) Serum luteinizing hormone (LH); and
 - (c) Serum total estrogen (females).
 - (iv) Any other tests deemed appropriate by the examining physician.
 - (3) Additional examinations. If the employee for any reason develops signs or symptoms commonly associated with exposure to DBCP, the employer shall provide the employee with a medical examination that shall include those elements considered appropriate by the examining physician.
 - (4) Information provided to the physician. The employer shall provide the following information to the examining physician:
 - (i) A copy of this regulation and its appendices;
 - (ii) A description of the affected employee's duties as they relate to the employee's exposure;
 - (iii) The level of DBCP to which the employee is exposed; and
 - (iv) A description of any personal protective equipment used or to be used.
 - (5) Physician's written opinion.
 - (i) For each examination under this section, the employer shall obtain and provide the employee with a written opinion from the examining physician that shall include:
 - (a) The results of the medical tests performed;
 - (b) The physician's opinion as to whether the employee has any detected medical condition which would place the employee at an increased risk of material impairment of health from exposure to DBCP; and
 - (c) Any recommended limitations upon the employee's exposure to DBCP or upon the use of protective clothing and equipment such as respirators.
 - (ii) The employer shall instruct the physician not to reveal in the written opinion specific findings or diagnoses unrelated to occupational exposure.
 - (6) Emergency situations. If the employee is exposed to DBCP in an emergency situation, the employer shall provide the employee with a sperm count test as soon as practicable, or, if the employee has been vasectomized or is unable to produce a semen specimen, the hormone tests contained in paragraph (m)(2)(iii) of this section. The employer shall provide these same tests three months later.
- (n) Employee information and training.**
 - (1) Training program.
 - (i) The employer shall institute a training program for all employees who may be exposed to DBCP and shall assure their participation in such training program.
 - (ii) The employer shall assure that each employee is informed of the following:
 - (a) The information contained in Appendix A;

- (b) The quantity, location, manner of use, release or storage of DBCP and the specific nature of operations which could result in exposure to DBCP as well as any necessary protective steps;
 - (c) The purpose, proper use, and limitations of respirators;
 - (d) The purpose and description of the medical surveillance program required by paragraph (m) of this section; and
 - (e) A review of this standard, including appendices.
- (2) Access to training materials.
 - (i) The employer shall make a copy of this standard and its appendices readily available to all affected employees.
 - (ii) The employer shall provide, upon request, all materials relating to the employee information and training program to the Assistant Secretary and the Director.
- (o) Signs and labels.
 - (1) General.
 - (i) The employer may use labels or signs required by other statutes, regulations, or ordinances in addition to or in combination with, signs and labels required by this paragraph.
 - (ii) The employer shall assure that no statement appears on or near any sign or label required by this paragraph that contradicts or detracts from the required sign or label.
 - (2) Signs.
 - (i) The employer shall post signs to clearly indicate all regulated areas. These signs shall bear the legend:

DANGER
1,2-Dibromo-3-chloropropane
 (Insert appropriate trade or common names)
CANCER HAZARD
AUTHORIZED PERSONNEL ONLY
RESPIRATOR REQUIRED

- (3) Labels.
 - (i) The employer shall assure that precautionary labels are affixed to all containers of DBCP and of products containing DBCP in the workplace, and that the labels remain affixed when the DBCP or products containing DBCP are sold, distributed, or otherwise leave the employer's workplace. Where DBCP or products containing DBCP are sold, distributed or otherwise leave the employer's workplace bearing appropriate labels required by EPA under the regulations in 40 CFR Part 162, the labels required by this paragraph need not be affixed.
 - (ii) The employer shall assure that the precautionary labels required by this paragraph are readily visible and legible. The labels shall bear the following legend:

DANGER
1,2-Dibromo-3-chloropropane
CANCER HAZARD

- (p) Record Keeping.
 - (1) Exposure monitoring.
 - (i) The employer shall establish and maintain an accurate record of all monitoring required by paragraph (f) of this section.
 - (ii) This record shall include:
 - (a) The dates, number, duration and results of each of the samples taken, including a description of the sampling procedure used to determine representative employee exposure;
 - (b) A description of the sampling and analytical methods used;
 - (c) Type of respiratory protective devices worn, if any; and
 - (d) Name, social security number, and job classification of the employee monitored and of all other employees whose exposure the measurement is intended to represent.
 - (iii) The employer shall maintain this record for at least 40 years or the duration of employment plus 20 years, whichever is longer.
 - (2) Medical surveillance.

- (i) The employer shall establish and maintain an accurate record for each employee subject to medical surveillance required by paragraph (m) of this section.
- (ii) This record shall include:
 - (a) The name and social security number of the employee;
 - (b) A copy of the physician's written opinion;
 - (c) Any employee medical complaints related to exposure to DBCP;
 - (d) A copy of the information provided the physician as required by paragraphs (m)(4)(ii) through (m)(4)(iv) of this section; and
 - (e) A copy of the employee's medical and work history.
- (iii) The employer shall maintain this record for at least 40 years or the duration of employment plus 20 years, whichever is longer.
- (3) Availability.
 - (i) The employer shall assure that all records required to be maintained by this section be made available upon request to the Assistant Secretary and the Director for examination and copying.
 - (ii) Employee exposure monitoring records and employee medical records required by this paragraph shall be provided upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.20(a) through (e) and (g) through (i).
- (4) Transfer of records.
 - (i) If the employer ceases to do business, the successor employer shall receive and retain all records required to be maintained by paragraph (p) of this section for the prescribed period.
 - (ii) If the employer ceases to do business and there is no successor employer to receive and retain the records for the prescribed period, the employer shall transmit these records by mail to the Director.
 - (iii) At the expiration of the retention period for the records required to be maintained under paragraph (p) of this section, the employer shall transmit these records by mail to the Director.
 - (iv) The employer shall also comply with any additional requirements involving transfer of records set forth in 29 CFR 1910.20(h).
- (q) Observation of monitoring.
 - (1) Employee observation. The employer shall provide affected employees, or their designated representatives, with an opportunity to observe any monitoring of employee exposure to DBCP required by this section.
 - (2) Observation procedures.
 - (i) Whenever observation of the measuring or monitoring of employee exposure to DBCP requires entry into an area where the use of protective clothing or equipment is required, the employer shall provide the observer with personal protective clothing or equipment required to be worn by employees working in the area, assure the use of such clothing and equipment, and require the observer to comply with all other applicable safety and health procedures.
 - (ii) Without interfering with the monitoring or measurement, observers shall be entitled to:
 - (a) Receive an explanation of the measurement procedures;
 - (b) Observe all steps related to the measurement of airborne concentrations of DBCP performed at the place of exposure; and
 - (c) Record the results obtained.
- (r) Appendices. The information contained in the appendices is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation.

APPENDIX A to §1910.1044 SUBSTANCE SAFETY DATA SHEET FOR DBCP

I. SUBSTANCE IDENTIFICATION

- A. Synonyms and trades names: DBCP; Dibromochloropropane; Fumazone (Dow Chemical Company TM); Nemaflume; Nemagon (Shell Chemical Co. TM); Nemaset; BBC 12; and OS 1879.
- B. Permissible exposure:

1. Airborne. 1 part DBCP vapor per billion parts of air (1 ppb); time-weighted average (TWA) for an 8-hour workday.
 2. Dermal. Eye contact and skin contact with DBCP are prohibited.
- C.** Appearance and odor: Technical grade DBCP is a dense yellow or amber liquid with a pungent odor. It may also appear in granular form, or blended in varying concentrations with other liquids.
- D.** Uses: DBCP is used to control nematodes, very small worm-like plant parasites, on crops including cotton, soybeans, fruits, nuts, vegetables and ornamentals.

II. HEALTH HAZARD DATA

- A.** Routes of entry: Employees may be exposed:
1. Through inhalation (breathing);
 2. Through ingestion (swallowing);
 3. Skin contact; and
 4. Eye contact.
- B.** Effects of exposure:
1. Acute exposure. DBCP may cause drowsiness, irritation of the eyes, nose, throat and skin, nausea and vomiting. In addition, overexposure may cause damage to the lungs, liver or kidneys.
 2. Chronic exposure. Prolonged or repeated exposure to DBCP has been shown to cause sterility in humans. It also has been shown to produce cancer and sterility in laboratory animals and has been determined to constitute an increased risk of cancer in man.
 3. Reporting Signs and Symptoms. If you develop any of the above signs or symptoms that you think are caused by exposure to DBCP, you should inform your employer.

III. EMERGENCY FIRST AID PROCEDURES

- A.** Eye exposure. If DBCP liquid or dust containing DBCP gets into your eyes, wash your eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with DBCP.
- B.** Skin exposure. If DBCP liquids or dusts containing DBCP get on your skin, immediately wash using soap or mild detergent and water. If DBCP liquids or dusts containing DBCP penetrate through your clothing, remove the clothing immediately and wash. If irritation is present after washing get medical attention.
- C.** Breathing. If you or any person breathes in large amounts of DBCP, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Do not use mouth-to-mouth. Keep the affected person warm and at rest. Get medical attention as soon as possible.
- D.** Swallowing. When DBCP has been swallowed and the person is conscious, give the person large amounts of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.
- E.** Rescue. Notify someone. Put into effect the established emergency rescue procedures. Know the locations of the emergency rescue equipment before the need arises.

IV. RESPIRATORS AND PROTECTIVE CLOTHING

- A.** Respirators. You may be required to wear a respirator in emergencies and while your employer is in the process of reducing DBCP exposures through engineering controls. If respirators are worn, they must have a National Institute for Occupational Safety and Health (NIOSH) approval label (Older respirators may have a Bureau of Mines Approval label). For effective protection, a respirator must fit your face and head snugly. The respirator should not be loosened or removed in work situations where its use is required. DBCP does not have a detectable odor except at 1,000 times or more above the permissible exposure limit. If you can smell DBCP while wearing a respirator, the respirator is not working correctly; go immediately to fresh air. If you experience difficulty breathing while wearing a respirator, tell your employer.
- B.** Protective clothing. When working with DBCP you must wear for your protection impermeable work clothing provided by your employer. (Standard rubber and neoprene protective clothing do not offer adequate protection).
 DBCP must never be allowed to remain on the skin. Clothing and shoes must not be allowed to become contaminated with DBCP, and if they do, they must be promptly removed and not worn

again until completely free of DBCP. Turn in impermeable clothing that has developed leaks for repair or replacement.

- C. Eye protection. You must wear splash-proof safety goggles where there is any possibility of DBCP liquid or dust contacting your eyes.

V. PRECAUTIONS FOR SAFE USE, HANDLING, AND STORAGE

- A. DBCP must be stored in tightly closed containers in a cool, well-ventilated area.
- B. If your work clothing may have become contaminated with DBCP, or liquids or dusts containing DBCP, you must change into uncontaminated clothing before leaving the work premises.
- C. You must promptly remove any protective clothing that becomes contaminated with DBCP. This clothing must not be re-worn until the DBCP is removed from the clothing.
- D. If your skin becomes contaminated with DBCP, you must immediately and thoroughly wash or shower with soap or mild detergent and water to remove any DBCP from your skin.
- E. You must not keep food, beverages, cosmetics, or smoking materials, nor eat or smoke, in regulated areas.
- F. If you work in a regulated area, you must wash your hands thoroughly with soap or mild detergent and water, before eating, smoking or using toilet facilities.
- G. If you work in a regulated area, you must remove any protective equipment or clothing before leaving the regulated area.
- H. Ask your supervisor where DBCP is used in your work area and for any additional safety and health rules.

VI. ACCESS TO INFORMATION

- A. Each year, your employer is required to inform you of the information contained in this Substance Safety Data Sheet for DBCP. In addition, your employer must instruct you in the safe use of DBCP, emergency procedures, and the correct use of protective equipment.
- B. Your employer is required to determine whether you are being exposed to DBCP. You or your representative have the right to observe employee exposure measurements and to record the result obtained. Your employer is required to inform you of your exposure. If your employer determines that you are being overexposed, he is required to inform you of the actions which are being taken to reduce your exposure.
- C. Your employer is required to keep records of your exposure and medical examinations. Your employer is required to keep exposure and medical data for at least 40 years or the duration of your employment plus 20 years, whichever is longer.
- D. Your employer is required to release exposure and medical records to you, your physician, or other individual designated by you upon your written request.

APPENDIX B to §1910.1044 SUBSTANCE TECHNICAL GUIDELINES FOR DBCP

I. PHYSICAL AND CHEMICAL DATA

- A. Substance Identification**
1. Synonyms: 1,2-dibromo-3-chloropropane; DBCP, Fumazone; Nemaforme; Nemagon; Nemaset; BBC 12; OS 1879. DBCP is also included in agricultural pesticides and fumigants that include the phrase "Nema---" in their name.
 2. Formula: $C_3H_5Br_2Cl$.
 3. Molecular Weight: 236.
- B. Physical Data:**
1. Boiling point (760 mm HG): 195C (383F)
 2. Specific gravity (water=1): 2.093.
 3. Vapor density (air=1 at boiling point of DBCP): Data not available.
 4. Melting point: 6C (43F).
 5. Vapor pressure at 20C (68F): 0.8 mm Hg
 6. Solubility in water: 1000 ppm.
 7. Evaporation rate (Butyl Acetate=1): very much less than 1.
 8. Appearance and odor: Dense yellow or amber liquid with a pungent odor at high concentrations. Any detectable odor of DBCP indicates overexposure.

II. FIRE EXPLOSION AND REACTIVITY HAZARD DATA

- A. Fire**
1. Flash point: 170F (77C)
 2. Autoignition temperature: Data not available.
 3. Flammable limits in air, percent by volume: Data not available.
 4. Extinguishing media: Carbon dioxide, dry chemical.
 5. Special fire-fighting procedures: Do not use a solid stream of water since a stream will scatter and spread the fire. Use water spray to cool containers exposed to a fire.
 6. Unusual fire and explosion hazards: None known.
 7. For purposes of complying with the requirements of §1910.106, liquid DBCP is classified as a Class III A combustible liquid.
 8. For the purpose of complying with §1910.309, the classification of hazardous locations as described in article 500 of the National Electrical Code for DBCP shall be Class I, Group D.
 9. For the purpose of compliance with §1910.157, DBCP is classified as a Class B fire hazard.
 10. For the purpose of compliance with §1910.178, locations classified as hazardous locations due to the presence of DBCP shall be Class I, Group D.
 11. Sources of ignition are prohibited where DBCP presents a fire or explosion hazard.
- B. Reactivity.**
1. Conditions contributing to instability: None known.
 2. Incompatibilities: Reacts with chemically active metals, such as aluminum, magnesium and tin alloys.
 3. Hazardous decomposition products: Toxic gases and vapors (such as HBr, HCl and carbon monoxide) may be released in a fire involving DBCP.
 4. Special precautions: DBCP will attack some rubber materials and coatings.

III. SPILL, LEAK AND DISPOSAL PROCEDURES

- A.** If DBCP is spilled or leaked, the following steps should be taken:
1. The area should be evacuated at once and re-entered only after thorough ventilation.
 2. Ventilate area of spill or leak.
 3. If in liquid form, collect for reclamation or absorb in paper, vermiculite, dry sand, earth or similar material.
 4. If in solid form, collect spilled material in the most convenient and safe manner for reclamation or for disposal.
- B.** Persons not wearing protective equipment must be restricted from areas of spills or leaks until cleanup has been completed.
- C. Waste Disposal Methods:**
1. For small quantities of liquid DBCP, absorb on paper towels, remove to a safe place (such as a

- fume hood) and burn the paper. Large quantities can be reclaimed or collected and atomized in a suitable combustion chamber equipped with an appropriate effluent gas-cleaning device. If liquid DBCP is absorbed in vermiculite, dry sand, earth or similar material and placed in sealed containers it may be disposed of in a State-approved sanitary landfill.
2. If in solid form, for small quantities, place on paper towels, remove to a safe place (such as a fume hood) and burn. Large quantities may be reclaimed. However, if this is not practical, dissolve in a flammable solvent (such as alcohol) and atomize in a suitable combustion chamber equipped with an appropriate effluent gas-cleaning device. DBCP in solid form may also be disposed in a state-approved sanitary landfill.

IV. MONITORING AND MEASUREMENT PROCEDURES

- A. Exposure above the permissible exposure limit.
 1. Eight Hour Exposure Evaluation: Measurements taken for the purpose of determining employee exposure under this section are best taken so that the average 8-hour exposure may be determined from a single 8-hour sample or two (2) 4-hour samples. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee).
 2. Monitoring Techniques: The sampling and analysis under this section may be performed by collecting the DBCP vapor on petroleum based charcoal absorption tubes with subsequent chemical analyses. The method of measurement chosen should determine the concentration of airborne DBCP at the permissible exposure limit to an accuracy of plus or minus 25 percent. If charcoal tubes are used, a total volume of 10 liters should be collected at a flow rate of 50 cc. per minute for each tube. Analyze the resultant samples as you would samples of halogenated solvent.
- B. Since many of the duties relating to employee protection are dependent on the results of monitoring and measuring procedures, employers should assure that the evaluation of employee exposures is performed by a competent industrial hygienist or other technically qualified person.

V. PROTECTIVE CLOTHING

Employees should be required to wear appropriate protective clothing to prevent any possibility of skin contact with DBCP. Because DBCP is absorbed through the skin, it is important to prevent skin contact with both liquid and solid forms of DBCP. Protective clothing should include impermeable coveralls or similar full body work clothing, gloves, head coverings, and work shoes or shoe coverings. Standard rubber and neoprene gloves do not offer adequate protection and should not be relied upon to keep DBCP off the skin. DBCP should never be allowed to remain on the skin. Clothing and shoes should not be allowed to become contaminated with the material, and if they do, they should be promptly removed and not worn again until completely free of the material. Any protective clothing that has developed leaks or is otherwise found to be defective should be repaired or replaced. Employees should also be required to wear splash-proof safety goggles where there is any possibility of DBCP contacting the eyes.

VI. HOUSEKEEPING AND HYGIENE FACILITIES

1. The workplace must be kept clean, orderly and in a sanitary condition;
2. Dry sweeping and the use of compressed air are unsafe for the cleaning of floors and other surfaces where DBCP dust or liquids are found. To minimize the contamination of air with dust, vacuuming with either portable or permanent systems must be used. If a portable unit is selected, the exhaust must be attached to the general workplace exhaust ventilation system, or collected within the vacuum unit equipped with high efficiency filters or other appropriate means of contamination removal and not used for other purposes. Units used to collect DBCP must be labeled.
3. Adequate washing facilities with hot and cold water must be provided, and maintained in a sanitary condition. Suitable cleansing agents should also be provided to assure the effective removal of DBCP from the skin.
4. Change or dressing rooms with individual clothes storage facilities must be provided to prevent the contamination of street clothes with DBCP. Because of the hazardous nature of DBCP, contaminated protective clothing must be stored in closed containers for cleaning or disposal.

VII. MISCELLANEOUS PRECAUTIONS

- A. Store DBCP in tightly closed containers in a cool, well ventilated area.
- B. Use of supplied-air suits or other impervious clothing (such as acid suits) may be necessary to prevent skin contact with DBCP. Supplied-air suits should be selected, used, and maintained under the supervision of persons knowledgeable in the limitations and potential life-endangering characteristics of supplied-air suits.
- C. The use of air-conditioned suits may be necessary in warmer climates.
- D. Advise employees of all areas and operations where exposure to DBCP could occur.

VIII. COMMON OPERATIONS

Common operations in which exposure to DBCP is likely to occur are: during its production; and during its formulation into pesticides and fumigants.

APPENDIX C to §1910.1044 MEDICAL SURVEILLANCE GUIDELINES FOR DBCP

I. ROUTE OF ENTRY

Inhalation; skin absorption

II. TOXICOLOGY

Recent data collected on workers involved in the manufacture and formulation of DBCP has shown that DBCP can cause sterility at very low levels of exposure. This finding is supported by studies showing that DBCP causes sterility in animals. Chronic exposure to DBCP resulted in pronounced necrotic action on the parenchymatous organs (i.e., liver, kidney, spleen) and on the testicles of rats at concentrations as low as 5 ppm. Rats that were chronically exposed to DBCP also showed changes in the composition of the blood, showing low RBC, hemoglobin, and WBC, and high reticulocyte levels as well as functional hepatic disturbance, manifesting itself in a long prothrombin time. Reznik et al. noted a single dose of 100 mg produced profound depression of the nervous system of rats. Their condition gradually improved. Acute exposure also resulted in the destruction of the sex gland activity of male rats as well as causing changes in the estrous cycle in female rats. Animal studies have also associated DBCP with an increased incidence of carcinoma. Olson, et al. orally administered DBCP to rats and mice 5 times per week at experimentally predetermined maximally tolerated doses and at half those doses. As early as ten weeks after initiation of treatment, DBCP induce a high incidence of squamous cell carcinomas of the stomach with metastases in both species. DBCP also induced mammary adenocarcinomas in the female rats at both dose levels.

III. SIGNS AND SYMPTOMS

- A. Inhalation: Nausea, eye irritation, conjunctivitis, respiratory irritation, pulmonary congestion or edema, CNS depression with apathy, sluggishness, and ataxia.
- B. Dermal: Erythema or inflammation and dermatitis on repeated exposure.

IV. SPECIAL TESTS

- A. Semen analysis: The following information excerpted from the document "Evaluation of Testicular Function", submitted by the Corporate Medical Department of the Shell Oil Company (exhibit 39-3), may be useful to physicians conducting the medical surveillance program; In performing semen analyses certain minimal but specific criteria should be met:
 1. It is recommended that a minimum of three valid semen analyses be obtained in order to make a determination of an individual's average sperm count.
 2. A period of sexual abstinence is necessary prior to the collection of each masturbatory sample. It is recommended that intercourse or masturbation be performed 48 hours before the actual specimen collection. A period of 48 hours of abstinence would follow; then the masturbatory sample would be collected.

3. Each semen specimen should be collected in a clean, wide mouthed, glass jar (not necessarily pre-sterilized) in a manner designated by the examining physician. Any part of the seminal fluid exam should be initialed only after liquefaction is complete, i.e., 30 to 45 minutes after collection.
 4. Semen volume should be measured to the nearest 1/10 of a cubic centimeter.
 5. Sperm density should be determined using routine techniques involving the use of a white cell pipette and a hemocytometer chamber. The immobilizing fluid most effective and most easily obtained for this process is distilled water.
 6. Thin, dry smears of the semen should be made for a morphologic classification of the sperm forms and should be stained with either hematoxylin or the more difficult, yet more precise, Papanicolaou technique. Also of importance to record is obvious sperm agglutination, pyospermia, delayed liquefaction (greater than 30 minutes), and hyperviscosity. In addition, pH, using nitrazine paper, should be determined.
 7. A total morphology evaluation should include percentages of the following:
 - a. Normal (oval) forms,
 - b. Tapered forms,
 - c. Amorphous forms (include large and small sperm shapes),
 - d. Duplicated (either heads or tails) forms, and
 - e. Immature forms.
 8. Each sample should be evaluated for sperm viability (percent viable sperm moving at the time of examination) as well as sperm motility (subjective characterization of "purposeful forward sperm progression" of the majority of those viable sperm analyzed) within two hours after collection, ideally by the same or equally qualified examiner.
- B.** Serum determinations: The following serum determinations should be performed by radioimmunoassay techniques using National Institutes of Health (NIH) specific antigen or antigen preparations of equivalent sensitivity:
1. Serum follicle stimulating hormone (FSH);
 2. Serum luteinizing hormone (LH); and
 3. Serum total estrogen (females only).

V. TREATMENT

Remove from exposure immediately, give oxygen or artificial resuscitation if indicated. Contaminated clothing and shoes should be removed immediately. Flush eyes and wash contaminated skin. If swallowed and the person is conscious, induce vomiting. Recovery from mild exposures is usually rapid and complete.

VI. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

- A.** Other considerations. DBCP can cause both acute and chronic effects. It is important that the physician become familiar with the operating conditions in which exposure to DBCP occurs. Those with respiratory disorders may not tolerate the wearing of negative pressure respirators.
- B.** Surveillance and screening. Medical histories and laboratory examinations are required for each employee subject to exposure to DBCP. The employer should screen employees for history of certain medical conditions (listed below) that might place the employee at increased risk from exposure.
1. Liver disease. The primary site of biotransformation and detoxification of DBCP is the liver. Liver dysfunctions likely to inhibit the conjugation reactions will tend to promote the toxic actions of DBCP. These precautions should be considered before exposing persons with impaired liver function to DBCP.
 2. Renal disease. Because DBCP has been associated with injury to the kidney it is important that special consideration be given to those with possible impairment of renal function.
 3. Skin disease. DBCP can penetrate the skin and can cause erythema on prolonged exposure. Persons with pre-existing skin disorders may be more susceptible to the effects of DBCP.
 4. Blood dyscrasias. DBCP has been shown to decrease the content of erythrocytes, hemoglobin, and leukocytes in the blood, as well as increase the prothrombin time. Persons with existing blood disorders may be more susceptible to the effects of DBCP.
 5. Reproductive disorders. Animal studies have associated DBCP with various effects on the reproductive organs. Among these effects are atrophy of the testicles and changes in the

estrous cycle. Persons with pre-existing reproductive disorders may be at increased risk to these effects of DBCP.

(b) Definitions. As used in 29 CFR section 1910.1044 and applied to this section:

"§1910.20" means section 1910.20 in section 12-202-3.

"§1910.134" means section 1910.134 in section 12-64.1-1.

"§1910.141" means section 1910.141 in Chapter 12-67. [Eff 7/6/98; am 3/31/06] (Auth: HRS §396-4) (Imp: HRS §396-4)

Historical note: §12-202-29.1 is based substantially upon section 12-202-29. [Eff 7/12/82; R 7/6/98]

§12-202-30.1 Acrylonitrile. (a) Incorporation of federal standard, Title 29 Code of Federal Regulations, section 1910.1045, entitled "Acrylonitrile" published by the Office of the Federal Register, National Archives and Records Administration on October 3, 1978; and the amendments published on May 23, 1980; June 7, 1989; June 30, 1993; February 13, 1996; January 8, 1998; and April 23, 1998; and January 5, 2005, are made a part of this section, except as provided in subsection (b).

§1910.1045 Acrylonitrile.

(a) Scope and application.

- (1) This section applies to all occupational exposures to acrylonitrile (AN), Chemical Abstracts Service Registry No. 000107131, except as provided in paragraphs (a)(2) and (a)(3) of this section.
- (2) This section does not apply to exposures that result solely from the processing, use, and handling of the following materials:
 - (i) ABS resins, SAN resins, nitrile barrier resins, solid nitrile elastomers, and acrylic and modacrylic fibers, when these listed materials are in the form of finished polymers, and products fabricated from such finished polymers;
 - (ii) Materials made from and/or containing AN for which objective data is reasonably relied upon to demonstrate that the material is not capable of releasing AN in airborne concentrations in excess of 1 ppm as an eight (8)-hour time-weighted average, under the expected conditions of processing, use, and handling which will cause the greatest possible release; and
 - (iii) Solid materials made from and/or containing AN which will not be heated above 170° F during handling, use, or processing.
- (3) An employer relying upon exemption under paragraph (a)(2)(ii) shall maintain records of the objective data supporting that exemption, and of the basis of the employer's reliance on the data, as provided in paragraph (q) of this section.

(b) Definitions.

Acrylonitrile or **AN** means acrylonitrile monomer, chemical formula $\text{CH}_2=\text{CHCN}$.

Action level means a concentration of AN of 1 ppm as an eight (8)-hour time-weighted average.

Assistant Secretary means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

Authorized person means any person specifically authorized by the employer whose duties require the person to enter a regulated area, or any person entering such an area as a designated representative of employees for the purpose of exercising the opportunity to observe monitoring procedures under paragraph (r) of this section.

Decontamination means treatment of materials and surfaces by water wash down, ventilation, or other means, to assure that the materials will not expose employees to airborne concentrations of AN above 1 means the Director, National Institute for Occupational Safety and Health, U.S. Department of Health, and Human Services, or designee.

Emergency means any occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment, which results in an unexpected massive release of AN.

Liquid AN means AN monomer in liquid form, and liquid or semi liquid polymer intermediates,

including slurries, suspensions, emulsions, and solutions, produced during the polymerization of AN.

OSHA Area Office means the Area Office of the Occupational Safety and Health

Administration having jurisdiction over the geographic area where the affected workplace is located.

(c) Permissible exposure limits.

(1) Inhalation.

- (i) Time weighted average limit (TWA). The employer shall assure that no employee is exposed to an airborne concentration of acrylonitrile in excess of two (2) parts acrylonitrile per million parts of air (2 ppm) as an eight (8)-hour time-weighted average.
- (ii) Ceiling limit. The employer shall assure that no employee is exposed to an airborne concentration of acrylonitrile in excess of ten (10) ppm as averaged over any fifteen (15)-minute period during the workday.

(2) Dermal and eye exposure. The employer shall assure that no employee is exposed to skin contact or eye contact with liquid AN.

(d) Notification of regulated areas and emergencies.

(1) Regulated areas. Within thirty (30) days following the establishment of a regulated area pursuant to paragraph (f) of this section, the employer shall report the following information to the OSHA Area Office:

- (i) The address and location of each establishment that has one or more regulated areas;
- (ii) The locations, within the establishment, of each regulated area;
- (iii) A brief description of each process or operation which results in employee exposure to AN in regulated areas; and,
- (iv) The number of employees engaged in each process or operation within each regulated area that results in exposure to AN, and an estimate of the frequency and degree of exposure that occurs.

Whenever there has been a significant change in the information required to be reported by this paragraph, the employer shall promptly provide the new information to the OSHA Area Office.

(2) Emergencies. Emergencies, and the facts obtainable at that time, shall be reported within seventy-two (72) hours of the initial occurrence to the OSHA Area Office. Upon request of the OSHA Area Office; the employer shall submit additional information in writing relevant to the nature and extent of employee exposures and measures taken to prevent future emergencies of a similar nature.

(e) Exposure monitoring.

(1) General.

- (i) Determinations of airborne exposure levels shall be made from air samples that are representative of each employee's exposure to AN over an eight (8)-hour period.
- (ii) For the purposes of this section, employee exposure is that exposure which would occur if the employee were not using a respirator.

(2) Initial monitoring. Each employer who has a place of employment in which AN is present shall monitor each such workplace and work operation to accurately determine the airborne concentrations of AN to which employees may be exposed.

(3) Frequency.

- (i) If the monitoring required by this section reveals employee exposure to be below the action level, the employer may discontinue monitoring for that employee.
- (ii) If the monitoring required by this section reveals employee exposure to be at or above the action level but below the permissible exposure limits, the employer shall repeat such monitoring for each such employee at least every six months. The employer must continue these measurements every six months until at least two consecutive measurements taken at least seven (7) days apart, are below the action level, and thereafter the employer may discontinue monitoring for that employee.
- (iii) If the monitoring required by this section reveals employee exposure to be in excess of the permissible exposure limits, the employer shall repeat these determinations for each such employee at least quarterly. The employer shall continue these quarterly measurements until at least two consecutive measurements, taken at least seven (7) days apart, are below the permissible exposure limits, and thereafter the employer must monitor at least every 6 months.

(4) Additional monitoring. Whenever there has been a production, process, control, or personnel change which may result in new or additional exposures to AN, or whenever the employer has any other reason to suspect a change which may result in new or additional exposures to AN,

additional monitoring which complies with this paragraph shall be conducted.

- (5) Employee notification.
 - (i) The employer must, within five 15 working days after the receipt of the results of any monitoring performed under this section, notify each affected employee of these results either individually in writing or by posting the results in an appropriate location that is accessible to employees.
 - (ii) Whenever the results indicate that the representative employee exposure exceeds the permissible exposure limits, the employer shall include in the written notice a statement that the permissible exposure limits were exceeded and a description of the corrective action being taken to reduce exposure to or below the permissible exposure limits.
- (6) Accuracy of measurement. The method of measurement of employee exposures shall be accurate to a confidence level of 95 percent, to within plus or minus 35 percent for concentrations of AN at or above the permissible exposure limits, and plus or minus 50 percent for concentrations of AN below the permissible exposure limits.
- (f) Regulated areas.
 - (1) The employer shall establish regulated areas where AN concentrations are in excess of the permissible exposure limits.
 - (2) Regulated areas shall be demarcated and segregated from the rest of the workplace, in any manner that minimizes the number of persons who will be exposed to AN.
 - (3) Access to regulated areas shall be limited to authorized persons or to persons otherwise authorized by the act or regulations issued pursuant thereto.
 - (4) The employer shall assure that food or beverages are not present or consumed, tobacco products are not present or used, and cosmetics are not applied in the regulated area.
- (g) Methods of compliance.
 - (1) Engineering and work practice controls.
 - (i) By November 2, 1980, the employer shall institute engineering and work practice controls to reduce and maintain employee exposures to AN, to or below the permissible exposure limits, except to the extent that the employer establishes that such controls are not feasible.
 - (ii) Wherever the engineering and work practice controls which can be instituted are not sufficient to reduce employee exposures to or below the permissible exposure limits, the employer shall nonetheless use them to reduce exposures to the lowest levels achievable by these controls, and shall supplement them by the use of respiratory protection which complies with the requirements of paragraph (h) of this section.
 - (2) Compliance program.
 - (i) The employer shall establish and implement a written program to reduce employee exposures to or below the permissible exposure limits solely by means of engineering and work practice controls, as required by paragraph (g)(1) of this section.
 - (ii) Written plans for these compliance programs shall include at least the following:
 - (A) A description of each operation or process resulting in employee exposure to AN above the permissible exposure limits;
 - (B) An outline of the nature of the engineering controls and work practices to be applied to the operation or process in question;
 - (C) A report of the technology considered in meeting the permissible exposure limits;
 - (D) A schedule for implementation of engineering and work practice controls for the operation or process, which shall project completion no later than November 2, 1980; and
 - (E) Other relevant information.
 - (iii) The employer shall complete the steps set forth in the compliance program by the dates in the schedule.
 - (iv) Written plans shall be submitted upon request to the Assistant Secretary and the Director, and shall be available at the worksite for examination and copying by the Assistant Secretary, the Director, or any affected employee or representative.
 - (v) The plans required by this paragraph must be revised and updated at least annually to reflect the current status of the program.
- (h) Respiratory protection.
 - (1) General. For employees who use respirators required by this section, the employer must provide respirators that comply with the requirements of this paragraph. Respirators must be used during:
 - (i) Periods necessary to install or implement feasible engineering and work-practice

- controls.
- (ii) Work operations, such as maintenance and repair activities or reactor cleaning, for which the employer establishes that engineering and work-practice controls are not feasible.
- (iii) Work operations for which feasible engineering and work-practice controls are not yet sufficient to reduce employee exposure to or below the permissible exposure limits.
- (iv) Emergencies.
- (2) Respirator program.
 - (i) The employer must implement a respiratory protection program in accordance with 29 CFR 1910.134(b) through (d) (except (d)(1)(iii), (d)(3)(iii)(B)(1), and (2)), and (f) through (m).
 - (ii) If air-purifying respirators (chemical-cartridge or chemical-canister types) are used:
 - (A) The air-purifying canister or cartridge must be replaced prior to the expiration of its service life or at the completion of each shift, whichever occurs first.
 - (B) A label must be attached to the cartridge or canister to indicate the date and time at which it is first installed on the respirator.
- (3) Respirator selection. The employer must select the appropriate respirator from Table I of this section.

TABLE I - RESPIRATORY PROTECTION FOR ACRYLONITRILE (AN)

Concentration of AN or condition of use	Respirator type
(a) Less than or equal to 20 ppm.....	(1) Chemical cartridge respirator with organic vapor cartridge(s) and half-mask facepiece; or
(b) Less than or equal to 100 ppm or maximum use concentration (MUC) of cartridges or canisters, whichever is lower.	(1) Full facepiece respirator with (A) organic vapor cartridges. (B) organic vapor gas mask chin-style, or (C) organic vapor gas mask canister, front- or back-mounted. (2) Supplied air respirator with full facepiece; or (3) Self-contained breathing apparatus with full facepiece.
(c) Less than or equal to 4,000 ppm.....	(1) Supplied air respirator operated in positive pressure mode with full facepiece, helmet, suit or hood.
(d) Greater than 4,000 ppm or unknown concentration.....	(1) Supplied air and auxiliary self-contained breathing apparatus with full facepiece in positive pressure mode; or (2) Self-contained breathing apparatus with full facepiece in positive pressure mode.
(e) Firefighting.....	Self-contained breathing apparatus with full facepiece in positive pressure mode.
(f) Escape.....	(1) Any organic vapor respirator, or (2) Any self-contained breathing apparatus

- (i) Emergency situations.
 - (1) Written plans.
 - (i) A written plan for emergency situations shall be developed for each workplace where liquid AN is present. Appropriate portions of the plan shall be implemented in the event of an emergency.
 - (ii) The plan shall specifically provide that employees engaged in correcting emergency conditions shall be equipped as required in paragraph (h) of this section until the emergency is abated.
 - (iii) Employees not engaged in correcting the emergency shall be evacuated from the area and shall not be permitted to return until the emergency is abated.

- (2) Alerting employees. Where there is the possibility of employee exposure to AN in excess of the ceiling limit, a general alarm shall be installed and used to promptly alert employees of such occurrences.
- (j) Protective clothing and equipment
 - (1) Provision and use. Where eye or skin contact with liquid AN may occur, the employer shall provide at no cost to the employee, and assure that employees wear, impermeable protective clothing or other equipment to protect any area of the body which may come in contact with liquid AN. The provision of §§1910.132 and 1910.133 shall be complied with.
 - (2) Cleaning and replacement.
 - (i) The employer shall clean, launder, maintain, or replace protective clothing and equipment required by this section as needed to maintain their effectiveness.
 - (ii) The employer shall assure that impermeable protective clothing which contacts or is likely to have contacted liquid AN shall be decontaminated before being removed by the employee.
 - (iii) The employer shall assure that an employee whose non-impermeable clothing becomes wetted with liquid AN shall immediately remove that clothing and proceed to shower. The clothing shall be decontaminated before it is removed from the regulated area.
 - (iv) The employer shall assure that no employee removes protective clothing or equipment from the change room, except for those employees authorized to do so for the purpose of laundering, maintenance, or disposal.
 - (v) The employer shall inform any person who launders or cleans protective clothing or equipment of the potentially harmful effects of exposure to AN.
- (k) House keeping.
 - (1) All surfaces shall be maintained free of visible accumulations of liquid AN.
 - (2) For operations involving liquid AN, the employer shall institute a program for detecting leaks and spills of liquid AN, including regular visual inspections.
 - (3) Where spills of liquid AN are detected, the employer shall assure that surfaces contacted by the liquid AN are decontaminated. Employees not engaged in decontamination activities shall leave the area of the spill, and shall not be permitted in the area until decontamination is completed.
- (l) Waste disposal. AN waste, scrap, debris, bags, containers, or equipment shall be decontaminated before being incorporated in the general waste disposal system.
- (m) Hygiene facilities and practices.
 - (1) Where employees are exposed to airborne concentrations of AN above the permissible exposure limits, or where employees are required to wear protective clothing or equipment pursuant to paragraph (j) of this section, the facilities required by 29 CFR 1910.141, including clean change rooms and shower facilities, shall be provided by the employer for the use of those employees, and the employer shall assure that the employees use the facilities provided.
 - (2) The employer shall assure that employees wearing protective clothing or equipment for protection from skin contact with liquid AN shall shower at the end of the work shift.
 - (3) The employer shall assure that, in the event of skin or eye exposure to liquid AN, the affected employee shall shower immediately to minimize the danger of skin absorption.
 - (4) The employer shall assure that employees working in the regulated area wash their hands and faces prior to eating.
- (n) Medical surveillance.
 - (1) General.
 - (i) The employer shall institute a program of medical surveillance for each employee who is or will be exposed to AN at or above the action level, without regard to the use of respirators. The employer shall provide each such employee with an opportunity for medical examinations and tests in accordance with this paragraph.
 - (ii) The employer shall assure that all medical examinations and procedures are performed by or under the supervision of a licensed physician, and that they shall be provided without cost to the employee.
 - (2) Initial examinations. At the time of initial assignment, or upon institution of the medical surveillance program, the employer shall provide each affected employee an opportunity for a medical examination, including at least the following elements:
 - (i) A work history and medical history with special attention to skin, respiratory, and gastrointestinal systems, and those nonspecific symptoms, such as headache, nausea, vomiting, dizziness, weakness, or other central nervous system dysfunctions that may be associated with acute or with chronic exposure to AN;

- (ii) A complete physical examination giving particular attention to the peripheral and central nervous system, gastrointestinal system, respiratory system, skin, and thyroid;
 - (iii) A 14- by 17-inch posteroanterior chest X-ray; and
 - (iv) Further tests of the intestinal tract, including fecal occult blood screening, for all workers 40 years of age or older, and for any other affected employees for whom, in the opinion of the physician, such testing is appropriate.
- (3) Periodic examinations.
 - (i) The employer shall provide the examinations specified in paragraph (n)(2) of this section at least annually for all employees specified in paragraph (n)(1) of this section.
 - (ii) If an employee has not had the examination specified in paragraph (n)(2) of this section within 6 months preceding termination of employment, the employer shall make such examination available to the employee prior to such termination.
- (4) Additional examinations. If the employee for any reason develops signs or symptoms which may be associated with exposure to AN, the employer shall provide an appropriate examination and emergency medical treatment.
- (5) Information provided to the physician. The employer shall provide the following information to the examining physician:
 - (i) A copy of this standard and its appendices;
 - (ii) A description of the affected employee's duties as they relate to the employee's exposure;
 - (iii) The employee's representative exposure level;
 - (iv) The employee's anticipated or estimated exposure level (for pre-placement examinations or in cases of exposure due to an emergency);
 - (v) A description of any personal protective equipment used or to be used; and
 - (vi) Information from previous medical examinations of the affected employee, which is not otherwise available to the examining physician.
- (6) Physician's written opinion.
 - (i) The employer shall obtain a written opinion from the examining physician that shall include:
 - (A) The results of the medical examination and test performed;
 - (B) The physician's opinion as to whether the employee has any detected medical condition(s) which would place the employee at an increased risk of material impairment of the employee's health from exposure to AN;
 - (C) Any recommended limitations upon the employee's exposure to AN or upon the use of protective clothing and equipment such as respirators; and
 - (D) A statement that the employee has been informed by the physician of the results of the medical examination and any medical conditions that require further examination or treatment.
 - (ii) The employer shall instruct the physician not to reveal in the written opinion specific findings or diagnoses unrelated to occupational exposure to AN.
 - (iii) The employer shall provide a copy of the written opinion to the affected employee.
- (o) Employee information and training.**
 - (1) Training program.
 - (i) By January 2, 1979, the employer shall institute a training program for and assure the participation of all employees exposed to AN above the action level, all employees whose exposures are maintained below the action level by engineering and work practice controls, and all employees subject to potential skin or eye contact with liquid AN.
 - (ii) Training shall be provided at the time of initial assignment, or upon institution of the training program, and at least annually thereafter, and the employer shall assure that each employee is informed of the following:
 - (A) The information contained in appendices A and B;
 - (B) The quantity, location, manner of use, release, or storage of AN, and the specific nature of operations which could result in exposure to AN, as well as any necessary protective steps;
 - (C) The purpose, proper use, and limitations of respirators and protective clothing;
 - (D) The purpose and a description of the medical surveillance program required by paragraph (n) of this section;
 - (E) The emergency procedures developed, as required by paragraph (i) of this section;

- (F) Engineering and work practice controls, their function, and the employee's relationship to these controls; and
 - (G) A review of this standard.
- (2) Access to training materials.
 - (i) The employer shall make a copy of this standard and its appendixes readily available to all affected employees.
 - (ii) The employer shall provide, upon request, all materials relating to the employee information and training program to the Assistant Secretary and the Director.
- (p) Signs and labels.
 - (1) General.
 - (i) The employer may use labels or signs required by other statutes, regulations, or ordinances in addition to, or in combination with, signs and labels required by this paragraph.
 - (ii) The employer shall assure that no statement appears on or near any sign or label required by this paragraph that contradicts or detracts from the required sign or label.
 - (2) Signs.
 - (i) The employer shall post signs to clearly indicate all workplaces where AN concentrations exceed the permissible exposure limits. The signs shall bear the following legend:

**DANGER
ACRYLONITRILE (AN)
CANCER HAZARD
AUTHORIZED PERSONNEL ONLY
RESPIRATORS MAY BE REQUIRED**

- (ii) The employer shall assure that signs required by this paragraph are illuminated and cleaned as necessary so that the legend is readily visible.
- (3) Labels.
 - (i) The employer shall assure that precautionary labels are affixed to all containers of liquid AN and AN-based materials not exempted under paragraph (a)(2) of this standard. The employer shall assure that the labels remain affixed when the materials are sold, distributed, or otherwise leave the employer's workplace.
 - (ii) The employer shall assure that the precautionary labels required by this paragraph are readily visible and legible. The labels shall bear the following legend:

**DANGER
CONTAINS ACRYLONITRILE (AN)
CANCER HAZARD**

- (q) Record Keeping.
 - (1) Objective data for exempted operations.
 - (i) Where the processing, use, and handling of materials made from or containing AN are exempted pursuant to paragraph (a)(2)(ii) of this section, the employer shall establish and maintain an accurate record of objective data reasonably relied upon in support of the exemption.
 - (ii) This record shall include at least the following information:
 - (A) The material qualifying for exemption;
 - (B) The source of the objective data;
 - (C) The testing protocol, results of testing, and/or analysis of the material for the release of AN;
 - (D) A description of the operation exempted and how the data supports the exemption; and
 - (E) Other data relevant to the operations, materials, and processing covered by the exemption.
 - (iii) The employer shall maintain this record for the duration of the employer's reliance upon such objective data.
 - (2) Exposure monitoring.

- (i) The employer shall establish and maintain an accurate record of all monitoring required by paragraph (e) of this section.
 - (ii) This record shall include:
 - (A) The dates, number, duration, and results of each of the samples taken, including a description of the sampling procedure used to determine representative employee exposure;
 - (B) A description of the sampling and analytical methods used and the data relied upon to establish that the methods used meet the accuracy and precision requirements of paragraph (e)(6) of this section;
 - (C) Type of respiratory protective devices worn, if any; and
 - (D) Name, social security number, and job classification of the employee monitored and of all other employees whose exposure the measurement is intended to represent.
 - (iii) The employer shall maintain this record for at least forty (40) years, or for the duration of employment plus twenty (20) years, whichever is longer.
- (3) Medical surveillance.
 - (i) The employer shall establish and maintain an accurate record for each employee subject to medical surveillance as required by paragraph (n) of this section.
 - (ii) This record shall include:
 - (A) A copy of the physician's written opinions;
 - (B) Any employee medical complaints related to exposure to AN;
 - (C) A copy of the information provided to the physician as required by paragraph (n)(5) of this section; and
 - (D) A copy of the employee's medical and work history.
 - (iii) The employer shall assure that this record be maintained for at least forty (40) years, or for the duration of employment plus twenty (20) years, whichever is longer.
- (4) Availability.
 - (i) The employer shall make all records required to be maintained by this section available, upon request, to the Assistant Secretary and the Director for examination and copying.
 - (ii) Records required by paragraphs (q)(1) - (q)(3) of this section shall be provided upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.20 (a) - (e) and (q) - (i). Records required by paragraph (q)(1) shall be provided in the same manner as exposure monitoring records.
- (5) Transfer of records.
 - (i) Whenever the employer ceases to do business, the successor employer shall receive and retain all records required to be maintained by this section for the prescribed period.
 - (ii) Whenever the employer ceases to do business and there is no successor employer to receive and retain the records for the prescribed period, these records shall be transmitted to the Director.
 - (iii) At the expiration of the retention period for the records required to be maintained pursuant to this section, the employer shall notify the Director at least 3 months prior to the disposal of the records, and shall transmit them to the Director upon request.
 - (iv) The employer shall also comply with any additional requirements involving transfer of records set forth in 29 CFR 1910.20(h).
- (r)** Observation of monitoring.
 - (1) Employee observation. The employer shall provide affected employees, or their designated representatives, an opportunity to observe any monitoring of employee exposure to AN conducted pursuant to paragraph (e) of this section.
 - (2) Observation procedures.
 - (i) Whenever observation of the monitoring of employee exposure to AN requires entry into an area where the use of protective clothing or equipment is required, the employer shall provide the observer with personal protective clothing and equipment required to be worn by employees working in the area, assure the use of such clothing and equipment, and require the observer to comply with all other applicable safety and health procedures.
 - (ii) Without interfering with the monitoring, observers shall be entitled:
 - (A) To receive an explanation of the measurement procedures;
 - (B) To observe all steps related to the measurement of airborne concentrations of AN performed at the place of exposure; and
 - (C) To record the results obtained.
- (s)** Effective date.

- (1) This section shall become effective November 2, 1978.
 - (2) Monitoring and medical surveillance conducted since January 17, 1978, under the provisions of the emergency temporary standard may be relied upon by the employer to meet the initial monitoring and initial medical surveillance requirements of this section.
 - (3) Training programs must be implemented by January 2, 1979.
 - (4) Engineering and work practice controls required by paragraph (g) of this section shall be implemented no later than November 2, 1980.
- (t) Appendixes. The information contained in the appendixes is not intended, by itself, to create any additional obligation not otherwise imposed, or to detract from any obligation.

APPENDIX A to §1910.1045 SUBSTANCE SAFETY DATA SHEET FOR ACRYLONITRILE

I. SUBSTANCE IDENTIFICATION

- A. Substance: Acrylonitrile (CH_2CHCN).
- B. Synonyms: Propenenitrile; vinyl cyanide; cyanoethylene; AN; VCN; acylon; carbacryl; fumigian; ventox.
- C. Acrylonitrile can be found as a liquid or vapor, and can also be found in polymer resins, rubbers, plastics, polyols, and other polymers having acrylonitrile as a raw or intermediate material.
- D. AN is used in the manufacture of acrylic and modiacrylic fibers, acrylic plastics and resins, speciality polymers, nitrile rubbers, and other organic chemicals. It has also been used as a fumigant.
- E. Appearance and odor: Colorless to pale yellow liquid with a pungent odor which can only be detected at concentrations above the permissible exposure level, in a range of 13-19 parts AN per million parts of air (13-19 ppm).
- F. Permissible exposure: Exposure may not exceed either:
 1. Two parts AN per million parts of air (2 ppm) averaged over the 8-hour workday; or
 2. Ten parts AN per million parts of air (10 ppm) averaged over any 15-minute period in the workday.
 3. In addition, skin and eye contact with liquid AN is prohibited.

II. HEALTH HAZARD DATA

- A. Acrylonitrile can affect your body if you inhale the vapor (breathing), if it comes in contact with your eyes or skin, or if you swallow it. It may enter your body through your skin.
- B. Effects of overexposure:
 1. Short-term exposure: Acrylonitrile can cause eye irritation, nausea, vomiting, headache, sneezing, weakness, and lightheadedness. At high concentrations, the effects of exposure may go on to loss of consciousness and death. When acrylonitrile is held in contact with the skin after being absorbed into shoe leather or clothing, it may produce blisters following several hours of no apparent effect. Unless the shoes or clothing are removed immediately and the area washed, blistering will occur. Usually there is no pain or inflammation associated with blister formation.
 2. Long-term exposure: Acrylonitrile has been shown to cause cancer in laboratory animals and has been associated with higher incidences of cancer in humans. Repeated or prolonged exposure of the skin to acrylonitrile may produce irritation and dermatitis.
 3. Reporting signs and symptoms: You should inform your employer if you develop any signs or symptoms and suspect they are caused by exposure to acrylonitrile.

III. EMERGENCY FIRST AID PROCEDURES

- A. Eye exposure: If acrylonitrile gets into your eyes, wash your eyes immediately with large amounts of water, lifting the lower and upper lids occasionally. Get medical attention immediately. Contact lenses should not be worn when working with this chemical.
- B. Skin exposure: If acrylonitrile gets on your skin, immediately wash the contaminated skin with water. If acrylonitrile soaks through your clothing, especially your shoes, remove the clothing immediately and wash the skin with water. If symptoms occur after washing, get medical attention immediately.

Thoroughly wash the clothing before reusing. Contaminated leather shoes or other leather articles should be discarded.

- C. Inhalation: If you or any other person breathes in large amounts of acrylonitrile, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Get medical attention as soon as possible.
- D. Swallowing: When acrylonitrile has been swallowed, give the person large quantities of water immediately. After the water has been swallowed, try to get the person to vomit by having him touch the back of his throat with his finger. Do not make an unconscious person vomit. Get medical attention immediately.
- E. Rescue: Move the affected person from the hazardous exposure. If the exposed person has been overcome, notify someone else and put into effect the established emergency procedures. Do not become a casualty yourself. Understand your emergency rescue procedures and know the location of the emergency equipment before the need arises.
- F. Special first aid procedures: First aid kits containing an adequate supply (at least two dozen) of amyl nitrite pearls, each containing 0.3 ml, should be maintained at each site where acrylonitrile is used. When a person is suspected of receiving an overexposure to acrylonitrile, immediately remove that person from the contaminated area using established rescue procedures. Contaminated clothing must be removed and the acrylonitrile washed from the skin immediately. Artificial respiration should be started at once if breathing has stopped. If the person is unconscious, amyl nitrite may be used as an antidote by a properly trained individual in accordance with established emergency procedures. Medical aid should be obtained immediately.

IV. RESPIRATORS AND PROTECTIVE CLOTHING

- A. Respirators. You may be required to wear a respirator for non-routine activities, in emergencies, while your employer is in the process of reducing acrylonitrile exposures through engineering controls, and in areas where engineering controls are not feasible. If respirators are worn, they must have a label issued by the National Institute for Occupational Safety and Health under the provisions of 42 CFR part 84 stating that the respirators have been approved for use with organic vapors. For effective protection, respirators must fit your face and head snugly. Respirators must not be loosened or removed in work situations where their use is required. Acrylonitrile does not have a detectable odor except at levels above the permissible exposure limits. Do not depend on odor to warn you when a respirator cartridge or canister is exhausted. Cartridges or canisters must be changed daily or before the end-of-service-life, whichever comes first. Reuse of these may allow acrylonitrile to gradually filter through the cartridge and cause exposures that you cannot detect by odor. If you can smell acrylonitrile while wearing a respirator, proceed immediately to fresh air. If you experience difficulty breathing while wearing a respirator, tell your employer.
- B. Supplied-air suits: In some work situations, the wearing of supplied-air suits may be necessary. Your employer must instruct you in their proper use and operation.
- C. Protective clothing: You must wear impervious clothing, gloves, face shield, or other appropriate protective clothing to prevent skin contact with liquid acrylonitrile. Where protective clothing is required, your employer is required to provide clean garments to you as necessary to assume that the clothing protects you adequately. Replace or repair impervious clothing that has developed leaks. Acrylonitrile should never be allowed to remain on the skin. Clothing and shoes that are not impervious to acrylonitrile should not be allowed to become contaminated with acrylonitrile, and if they do the clothing and shoes should be promptly removed and decontaminated. The clothing should be laundered or discarded after the AN is removed. Once acrylonitrile penetrates shoes or other leather articles, they should not be worn again.
- D. Eye protection: You must wear splash proof safety goggles in areas where liquid acrylonitrile may contact your eyes. In addition, contact lenses should not be worn in areas where eye contact with acrylonitrile can occur.

V. PRECAUTIONS FOR SAFE USE, HANDLING, AND STORAGE

- A. Acrylonitrile is a flammable liquid, and its vapors can easily form explosive mixtures in air.
- B. Acrylonitrile must be stored in tightly closed containers in a cool, well-ventilated area, away from heat, sparks, flames, strong oxidizers (especially bromine), strong bases, copper, copper alloys, ammonia, and amines.

- C. Sources of ignition such as smoking and open flames are prohibited wherever acrylonitrile is handled, used, or stored in a manner that could create a potential fire or explosion hazard.
- D. You should use non-sparking tools when opening or closing metal containers of acrylonitrile, and containers must be bonded and grounded when pouring or transferring liquid acrylonitrile.
- E. You must immediately remove any non-impervious clothing that becomes wetted with acrylonitrile, and this clothing must not be re-worn until the acrylonitrile is removed from the clothing.
- F. Impervious clothing wet with liquid acrylonitrile can be easily ignited. This clothing must be washed down with water before you remove it.
- G. If your skin becomes wet with liquid acrylonitrile, you must promptly and thoroughly wash or shower with soap or mild detergent to remove any acrylonitrile from your skin.
- H. You must not keep food, beverages, or smoking materials, nor are you permitted to eat or smoke in regulated areas where acrylonitrile concentrations are above the permissible exposure limits.
- I. If you contact liquid acrylonitrile, you must wash your hands thoroughly with soap or mild detergent and water before eating, smoking, or using toilet facilities.
- J. Fire extinguishers and quick drenching facilities must be readily available, and you should know where they are and how to operate them.
- K. Ask your supervisor where acrylonitrile is used in your work area and for any additional plant safety and health rules.

VI. ACCESS TO INFORMATION

- A. Each year, your employer is required to inform you of the information contained in this Substance Safety Data Sheet for acrylonitrile. In addition, your employer must instruct you in the proper work practices for using acrylonitrile, emergency procedures, and the correct use of protective equipment.
- B. Your employer is required to determine whether you are being exposed to acrylonitrile. You or your representative has the right to observe employee measurements and to record the results obtained. Your employer is required to inform you of your exposure. If your employer determines that you are being overexposed, he or she is required to inform you of the actions which are being taken to reduce your exposure to within permissible exposure limits.
- C. Your employer is required to keep records of your exposures and medical examinations. These records must be kept by the employer for at least forty (40) years or for the period of your employment plus twenty (20) years, whichever is longer.
- D. Your employer is required to release your exposure and medical records to you or your representative upon your request.

APPENDIX B to §1910.1045 SUBSTANCE TECHNICAL GUIDELINES FOR ACRYLONITRILE

I. PHYSICAL AND CHEMICAL DATA

- A. Substance identification:
 - 1. Synonyms: AN; VCN; vinyl cyanide; propenenitrile; cyanoethylene; Acrylon; Carbacryl; Fumigrain; Ventox.
 - 2. Formula: $\text{CH}_2 = \text{CHCN}$.
 - 3. Molecular weight: 53.1.
- B. Physical data:
 - 1. Boiling point (760 mm Hg): 77.3° C (171° F);
 - 2. Specific gravity (water = 1): 0.81 (at 20° C or 68° F);
 - 3. Vapor density (air=1 at boiling point of acrylonitrile): 1.83;
 - 4. Melting point: -83° C (-117° F);
 - 5. Vapor pressure (@20° F): 83 mm Hg;
 - 6. Solubility in water, percent by weight @20° C (68° F): 7.35;
 - 7. Evaporation rate (Butyl Acetate = 1): 4.54; and
 - 8. Appearance and odor: Colorless to pale yellow liquid with a pungent odor at concentrations above the permissible exposure level. Any detectable odor of acrylonitrile may indicate overexposure.

II. FIRE, EXPLOSION, AND REACTIVITY HAZARD DATA

- A. Fire:**
1. Flash point: -1° C (30° F) (closed cup).
 2. Autoignition temperature: 481° C (898° F).
 3. Flammable limits air, percent by volume: Lower: 3, Upper: 17.
 4. Extinguishing media: Alcohol foam, carbon dioxide, and dry chemical.
 5. Special fire-fighting procedures: Do not use a solid stream of water, since the stream will scatter and spread the fire. Use water to cool containers exposed to a fire.
 6. Unusual fire and explosion hazards: Acrylonitrile is a flammable liquid. Its vapors can easily form explosive mixtures with air. All ignition sources must be controlled where acrylonitrile is handled, used, or stored in a manner that could create a potential fire or explosion hazard. Acrylonitrile vapors are heavier than air and may travel along the ground and be ignited by open flames or sparks at locations remote from the site at which acrylonitrile is being handled.
 7. For purposes of compliance with the requirements of 29 CFR 1910.106, acrylonitrile is classified as a class IB flammable liquid. For example, 7,500 ppm, approximately one-fourth of the lower flammable limit, would be considered to pose a potential fire and explosion hazard.
 8. For purposes of compliance with 29 CFR 1910.157, acrylonitrile is classified as a Class B fire hazard.
 9. For purpose of compliance with 29 CFR 1919.309, locations classified as hazardous due to the presence of acrylonitrile shall be Class I, Group D.
- B. Reactivity:**
1. Conditions contributing to instability: Acrylonitrile will polymerize when hot, and the additional heat liberated by the polymerization may cause containers to explode. Pure AN may self-polymerize, with a rapid build-up of pressure, resulting in an explosion hazard. Inhibitors are added to the commercial product to prevent self-polymerization.
 2. Incompatibilities: Contact with strong oxidizers (especially bromine) and strong bases may cause fires and explosions. Contact with copper, copper alloys, ammonia, and amines may start serious decomposition.
 3. Hazardous decomposition products: Toxic gases and vapors (such as hydrogen cyanide, oxides of nitrogen, and carbon monoxide) may be released in a fire involving acrylonitrile and certain polymers made from acrylonitrile.
 4. Special precautions: Liquid acrylonitrile will attack some forms of plastics, rubbers, and coatings.

III. SPILL, LEAK, AND DISPOSAL PROCEDURES

- A.** If acrylonitrile is spilled or leaked, the following steps should be taken:
1. Remove all ignition sources.
 2. The area should be evacuated at once and re-entered only after the area has been thoroughly ventilated and washed down with water.
 3. If liquid acrylonitrile or polymer intermediate, collect for reclamation or absorb in paper, vermiculite, dry sand, earth, or similar material, or wash down with water into process sewer system.
- B.** Persons not wearing protective equipment should be restricted from areas of spills or leaks until clean up has been completed.
- C.** Waste disposal methods: Waste material shall be disposed of in a manner that is not hazardous to employees or to the general population. Spills of acrylonitrile and flushing of such spills shall be channeled for appropriate treatment or collection for disposal. They shall not be channeled directly into the sanitary sewer system. In selecting the method of waste disposal, applicable local, State, and Federal regulations should be consulted.

IV. MONITORING AND MEASUREMENT PROCEDURES

- A.** Exposure above the Permissible Exposure Limit:
1. Eight-hour exposure evaluation: Measurements taken for the purpose of determining employee exposure under this section are best taken so that the average 8-hour exposure may be determined from a single 8-hour sample or two (2) 4-hour samples. Air samples should be taken in the employee's breathing zone (air that would most nearly represent that inhaled by the employee.)

2. Ceiling evaluation: Measurements taken for the purpose of determining employee exposure under this section must be taken during periods of maximum expected airborne concentrations of acrylonitrile in the employee's breathing zone. A minimum of three (3) measurements should be taken on one work shift. The average of all measurements taken is an estimate of the employee's ceiling exposure.
3. Monitoring techniques: The sampling and analysis under this section may be performed by collecting the acrylonitrile vapor on charcoal adsorption tubes or other composition adsorption tubes, with subsequent chemical analysis. Sampling and analysis may also be performed by instruments such as real-time continuous monitoring systems, portable direct-reading instruments, or passive dosimeters. Analysis of resultant samples should be by gas chromatograph.

Appendix D lists methods of sampling and analysis that have been tested by NIOSH and OSHA for use with acrylonitrile. NIOSH and OSHA have validated modifications of NIOSH Method S-156 (See Appendix D) under laboratory conditions for concentrations below 1 ppm. The employer has the obligation of selecting a monitoring method that meets the accuracy and precision requirements of the standard under his unique field conditions. The standard requires that methods of monitoring must be accurate, to a 95-percent confidence level, to ± 35 -percent for concentrations of AN at or above 2 ppm, and to ± 50 -percent for concentrations below 2ppm. In addition to the methods described in Appendix D, there are numerous other methods available for monitoring for AN in the workplace. Details on these other methods have been submitted by various companies to the rulemaking record, and are available at the OSHA Docket Office.

- B. Since many of the duties relating to employee exposure are dependent on the results of monitoring and measuring procedures, employers shall assure that the evaluation of employee exposures is performed by a competent industrial hygienist or other technically qualified person.

V. PROTECTIVE CLOTHING

Employees shall be provided with and required to wear appropriate protective clothing to prevent any possibility of skin contact with liquid AN. Because acrylonitrile is absorbed through the skin, it is important to prevent skin contact with liquid AN. Protective clothing shall include impermeable coveralls or similar full-body work clothing, gloves, head-coverings, as appropriate to protect areas of the body which may come in contact with liquid AN.

Employers should ascertain that the protective garments are impermeable to acrylonitrile. Non-impermeable clothing and shoes should not be allowed to become contaminated with liquid AN. If permeable clothing does become contaminated, it should be promptly removed, placed in a regulated area for removal of the AN, and not worn again until the AN is removed. If leather footwear or other leather garments become wet from acrylonitrile, they should be replaced and not worn again, due to the ability of leather to absorb acrylonitrile and hold it against the skin. Since there is no pain associated with the blistering which may result from skin contact with liquid AN, it is essential that the employee be informed of this hazard so that he or she can be protected.

Any protective clothing that has developed leaks or is otherwise found to be defective shall be repaired or replaced. Clean protective clothing shall be provided to the employee as necessary to assure its protectiveness. Whenever impervious clothing becomes wet with liquid AN, it shall be washed down with water before being removed by the employee. Employees are also required to wear splash-proof safety goggles where there is any possibility of acrylonitrile contacting the eyes.

VI. HOUSEKEEPING AND HYGIENE FACILITIES

For purposes of complying with 29 CFR 1910.141, the following items should be emphasized:

- A. The workplace should be kept clean, orderly, and in a sanitary condition. The employer is required to institute a leak and spill detection program for operations involving liquid AN in order to detect sources of fugitive AN emissions.
- B. Dry sweeping and the use of compressed air is unsafe for the cleaning of floors and other surfaces where liquid AN may be found.
- C. Adequate washing facilities with hot and cold water are to be provided, and maintained in a sanitary condition. Suitable cleansing agents are also to be provided to assure the effective removal of acrylonitrile from the skin.
- D. Change or dressing rooms with individual clothes storage facilities must be provided to prevent the contamination of street clothes with acrylonitrile. Because of the hazardous nature of acrylonitrile, contaminated protective clothing should be placed in a regulated area designated by the employer

for removal of the AN before the clothing is laundered or disposed of.

VII. MISCELLANEOUS PRECAUTIONS

- A.** Store acrylonitrile in tightly closed containers in a cool, well-ventilated area and take necessary precautions to avoid any explosion hazard.
- B.** High exposures to acrylonitrile can occur when transferring the liquid from one container to another.
- C.** Non-sparking tools must be used to open and close metal acrylonitrile containers. These containers must be effectively grounded and bonded prior to pouring.
- D.** Never store uninhibited acrylonitrile.
- E.** Acrylonitrile vapors are not inhibited. They may form polymers and clog vents of storage tanks.
- F.** Use of supplied-air suits or other impervious coverings may be necessary to prevent skin contact with and provide respiratory protection from acrylonitrile where the concentration of acrylonitrile is unknown or is above the ceiling limit. Supplied-air suits should be selected, used, and maintained under the immediate supervision of persons knowledgeable in the limitations and potential life-endangering characteristics of supplied-air suits.
- G.** Employers shall advise employees of all areas and operations where exposure to acrylonitrile could occur.

VIII. COMMON OPERATIONS

Common operations in which exposure to acrylonitrile is likely to occur include the following: Manufacture of the acrylonitrile monomer; synthesis of acrylic fibers, ABS, SAN, and nitrile barrier plastics and resins, nitrile rubber, surface coatings, specialty chemicals, use as a chemical intermediate, use as a fumigant and in the cyanoethylation of cotton.

APPENDIX C to §1910.1045 MEDICAL SURVEILLANCE GUIDELINES FOR ACRYLONITRILE

I. ROUTE OF ENTRY

Inhalation; skin absorption; ingestion.

II. TOXICOLOGY

Acrylonitrile vapor is an asphyxiant due to inhibitory action on metabolic enzyme systems. Animals exposed to 75 or 100 ppm for 7 hours have shown signs of anoxia; in some animals which died at the higher level, cyanomethemoglobin was found in the blood. Two human fatalities from accidental poisoning have been reported; one was caused by inhalation of an unknown concentration of the vapor, and the other was thought to be caused by skin absorption or inhalation. Most cases of intoxication from industrial exposure have been mild, with rapid onset of eye irritation, headache, sneezing, and nausea. Weakness, lightheadedness, and vomiting may also occur. Exposure to high concentrations may produce profound weakness, asphyxia, and death. The vapor is a severe eye irritant. Prolonged skin contact with the liquid may result in absorption with systemic effects, and in the formation of large blisters after a latent period of several hours. Although there is usually little or no pain or inflammation, the affected skin resembles a second-degree thermal burn. Solutions spilled on exposed skin, or on areas covered only by a light layer of clothing, evaporate rapidly, leaving no irritation, or, at the most, mild transient redness. Repeated spills on exposed skin may result in dermatitis due to solvent effects.

Results after 1 year of a planned 2-year animal study on the effects of exposure to acrylonitrile have indicated that rats ingesting as little as 35 ppm in their drinking water develop tumors of the central nervous system. The interim results of this study have been supported by a similar study being conducted by the same laboratory, involving exposure of rats by inhalation of acrylonitrile vapor, which has shown similar types of tumors in animals exposed to 80 ppm.

In addition, the preliminary results of an epidemiological study being performed by DuPont on a cohort of workers in their Camden, S.C. acrylic fiber plant indicate a statistically significant increase in the incidence of colon and lung cancers among employees exposed to acrylonitrile.

III. SIGNS AND SYMPTOMS OF ACUTE OVEREXPOSURE

Asphyxia and death can occur from exposure to high concentrations of acrylonitrile. Symptoms of overexposure include eye irritation, headache, sneezing, nausea and vomiting, weakness, and lightheadedness. Prolonged skin contact can cause blisters on the skin with appearance of a second-degree burn, but with little or no pain. Repeated skin contact may produce scaling dermatitis.

IV. TREATMENT OF ACUTE OVEREXPOSURE

Remove employee from exposure. Immediately flush eyes with water and wash skin with soap or mild detergent and water. If AN has been swallowed, and person is conscious, induce vomiting. Give artificial resuscitation if indicated. More severe cases, such as those associated with loss of consciousness, may be treated by the intravenous administration of sodium nitrite, followed by sodium thiosulfate, although this is not as effective for acrylonitrile poisoning as for inorganic cyanide poisoning.

V. SURVEILLANCE AND PREVENTIVE CONSIDERATIONS

- A.** As noted above, exposure to acrylonitrile has been linked to increased incidence of cancers of the colon and lung in employees of the DuPont acrylic fiber plant in Camden, S.C. In addition, the animal testing of acrylonitrile has resulted in the development of cancers of the central nervous system in rats exposed by either inhalation or ingestion. The physician should be aware of the findings of these studies in evaluating the health of employees exposed to acrylonitrile.

Most reported acute effects of occupational exposure to acrylonitrile are due to its ability to cause tissue anoxia and asphyxia. The effects are similar to those caused by hydrogen cyanide. Liquid acrylonitrile can be absorbed through the skin upon prolonged contact. The liquid readily penetrates leather, and will produce burns of the feet if footwear contaminated with acrylonitrile is not removed.

It is important for the physician to become familiar with the operating conditions in which exposure to acrylonitrile may occur. Those employees with skin diseases may not tolerate the wearing of whatever protective clothing may be necessary to protect them from exposure. In addition, those with chronic respiratory disease may not tolerate the wearing of negative-pressure respirators.

- B.** Surveillance and screening. Medical histories and laboratory examinations are required for each employee subject to exposure to acrylonitrile above the action level. The employer must screen employees for history of certain medical conditions that might place the employee at increased risk from exposure.
1. Central nervous system dysfunction. Acute effects of exposure to acrylonitrile generally involve the central nervous system. Symptoms of acrylonitrile exposure include headache, nausea, dizziness, and general weakness. The animal studies cited above suggest possible carcinogenic effects of acrylonitrile on the central nervous system, since rats exposed by either inhalation or ingestion have developed similar CNS tumors.
 2. Respiratory disease. The DuPont data indicate an increased risk of lung cancer among employees exposed to acrylonitrile.
 3. Gastrointestinal disease. The DuPont data indicate an increased risk of cancer of the colon among employees exposed to acrylonitrile. In addition, the animal studies show possible tumor production in the stomachs of the rats in the ingestion study.
 4. Skin disease. Acrylonitrile can cause skin burns when prolonged skin contact with the liquid occurs. In addition, repeated skin contact with the liquid can cause dermatitis.
 5. General. The purpose of the medical procedures outlined in the standard is to establish a baseline for future health monitoring. Persons unusually susceptible to the effects of anoxia or those with anemia would be expected to be at increased risk. In addition to emphasis on the CNS, respiratory and gastrointestinal systems, the cardiovascular system, liver, and kidney function should also be stressed.

APPENDIX D to §1910.1045 SAMPLING AND ANALYTICAL METHODS FOR ACRYLONITRILE

There are many methods available for monitoring employee exposures to acrylonitrile. Most of these involve the use of charcoal tubes and sampling pumps, with analysis by gas chromatograph. The essential differences between the charcoal tube methods include, among others, the use of different

desorbing solvents, the use of different lots of charcoal, and the use of different equipment for analysis of the samples.

Besides charcoal, considerable work has been performed on methods using porous polymer sampling tubes and passive dosimeters. In addition, there are several portable gas analyzers and monitoring units available on the open market.

This appendix contains details for the methods that have been tested at OSHA Analytical Laboratory in Salt Lake City, and NIOSH in Cincinnati. Each is a variation on NIOSH Method S-156, which is also included for reference. This does not indicate that these methods are the only ones that will be satisfactory. There also may be workplace situations in which these methods are not adequate, due to such factors as high humidity. Copies of the other methods available to OSHA are available in the rulemaking record, and may be obtained from the OSHA Docket Office. These include, the Union Carbide, Monsanto, Dow Chemical and Dow Badische methods, as well as NIOSH Method P & CAM 127.

Employers who note problems with sample breakthrough should try larger charcoal tubes. Tubes of larger capacity are available, and are often used for sampling vinyl chloride. In addition, lower flow rates and shorter sampling times should be beneficial in minimizing breakthrough problems.

Whatever method the employer chooses, he must assure himself of the method's accuracy and precision under the unique conditions present in his workplace.

NIOSH METHOD S-156 (UNMODIFIED)

Analyte: Acrylonitrile.

Matrix: Air.

Procedure: Absorption on charcoal, desorption with methanol, GC.

1. Principle of the method (Reference 11.1).

1.1 A known volume of air is drawn through a charcoal tube to trap the organic vapors present.

1.2 The charcoal in the tube is transferred to a small, stoppered sample container, and the analyte is desorbed with methanol.

1.3 An aliquot of the desorbed sample is injected into a gas chromatograph.

1.4 The area of the resulting peak is determined and compared with areas obtained for standards.

2. Range and sensitivity.

2.1 This method was validated over the range of 17.5-70.0 mg/cu m at an atmospheric temperature and pressure of 22° C and 760 MM Hg, using a 20-liter sample. Under the conditions of sample size (20-liters) the probable useful range of this method is 4.5-135 mg-cu m. The method is capable of measuring much smaller amounts if the desorption efficiency is adequate. Desorption efficiency must be determined over the range used.

2.2 The upper limit of the range of the method is dependent on the adsorptive capacity of the charcoal tube. This capacity varies with the concentrations of acrylonitrile and other substances in the air. The first section of the charcoal tube was found to hold at least 3.97 mg of acrylonitrile when a test atmosphere containing 92.0 mg/cu m of acrylonitrile in air was sampled 0.18 liter per minute for 240 minutes; at that time the concentration of acrylonitrile in the effluent was less than 5 percent of that in the influent. (The charcoal tube consists of two sections of activated charcoal separated by a section of urethane foam. See section 6.2.) If a particular atmosphere is suspected of containing a large amount of contaminant, a smaller sampling volume should be taken.

3. Interference.

3.1 When the amount of water in the air is so great that condensation actually occurs in the tube, organic vapors will not be trapped efficiently. Preliminary experiments using toluene indicate that high humidity severely decreases the breakthrough volume.

3.2 When interfering compounds are known or suspected to be present in the air, such information, including their suspected identities, should be transmitted with the sample.

3.3 It must be emphasized that any compound that has the same retention time as the analyte at the operating conditions described in this method is an interference. Retention time data on a single column cannot be considered proof of chemical identity.

3.4 If the possibility of interference exists, separation conditions (column packing, temperature, etc.) must be changed to circumvent the problem.

4. Precision and accuracy.

4.1 The Coefficient of Variation (CV_T) for the total analytical and sampling method in the range of 17.5-70.0 mg/cu m was 0.073. This value corresponds to a 3.3 mg/cu m standard deviation at the (previous) OSHA standard level (20 ppm). Statistical information and details of the validation and experimental test procedures can be found in Reference 11.2.

4.2 On the average the concentrations obtained at the 20 ppm level using the overall sampling and analytical method were 6.0 percent lower than the "true" concentrations for a limited number of laboratory experiments. Any difference between the "found" and "true" concentrations may not represent a bias in the sampling and analytical method, but rather a random variation from the experimentally determined "true" concentration. Therefore, no recovery correction should be applied to the final result in section 10.5.

5. Advantages and disadvantages of the method.

5.1 The sampling device is small, portable, and involves no liquids. Interferences are minimal, and most of those that do occur can be eliminated by altering chromatographic conditions. The tubes are analyzed by means of a quick, instrumental method.

The method can also be used for the simultaneous analysis of two or more substances suspected to be present in the same sample by simply changing gas chromatographic conditions.

5.2 One disadvantage of the method is that the amount of sample that can be taken is limited by the number of milligrams that the tube will hold before overloading. When the sample value obtained for the backup section of the charcoal tube exceeds 25 percent of that found on the front section, the possibility of sample loss exists.

5.3 Furthermore, the precision of the method is limited by the reproducibility of the pressure drop across the tubes. This drop will affect the flow rate and cause the volume to be imprecise, because the pump is usually calibrated for one tube only.

6. Apparatus.

6.1 A calibrated personal sampling pump whose flow can be determined within + or - 5 percent at the recommended flow rate. (Reference 11.3).

6.2 Charcoal tubes: Glass tubes with both ends flame sealed, 7 cm long with a 6-mm O.D. and a 4-mm I.D., containing 2 sections of 20/40 mesh activated charcoal separated by a 2-mm portion of urethane foam. The activated charcoals prepared from coconut shells and are fired at 600 deg. C prior to packing. The adsorbing section contains 100 mg of charcoal, the backup section 50 mg. A 3-mm portion of urethane foam is placed between the outlet end of the tube and the backup section. A plug of silicated glass wool is placed in front of the adsorbing section. The pressure drop across the tube must be less than 1 inch of mercury at a flow rate of 1 liter per minute.

6.3 Gas chromatograph equipped with a flame ionization detector.

6.4 Column (4-ftX 1/4 -in stainless steel) packed with 50/80 mesh Poropak, type Q.

6.5 An electronic integrator or some other suitable method for measuring peak areas.

6.6 Two-milliliter sample containers with glass stoppers or Teflon-lined caps. If an automatic sample injector is used, the associated vials may be used.

6.7 Microliter syringes: 10-microliter and other convenient sizes for making standards.

6.8 Pipets: 1.0-ml delivery pipets.

6.9 Volumetric flask: 10-ml or convenient sizes for making standard solutions.

7. Reagents.

7.1 Chromatographic quality methanol.

7.2 Acrylonitrile, reagent grade.

7.3 Hexane, reagent grade.

7.4 Purified nitrogen.

7.5 Pre-purified hydrogen.

7.6 Filtered compressed air.

8. Procedure.

8.1 Cleaning of equipment. All glassware used for the laboratory analysis should be detergent washed and thoroughly rinsed with tap water and distilled water.

8.2 Calibration of personal pumps. Each personal pump must be calibrated with a representative charcoal tube in the line. This will minimize errors associated with uncertainties in the sample volume collected.

8.3 Collection and shipping of samples.

8.3.1 Immediately before sampling, break the ends of the tube to provide an opening at least one-half the internal diameter of the tube (2 mm).

8.3.2 The smaller section of charcoal is used as a backup and should be positioned nearest the sampling pump.

8.3.3 The charcoal tube should be placed in a vertical direction during sampling to minimize channeling through the charcoal.

8.3.4 Air being sampled should not be passed through any hose or tubing before entering the charcoal tube.

8.3.5 A maximum sample size of 20 liters is recommended. Sample at a flow of 0.20 liter per

minute or less. The flow rate should be known with an accuracy of at least ± 5 percent.

8.3.6 The temperature and pressure of the atmosphere being sampled should be recorded. If pressure reading is not available, record the elevation.

8.3.7 The charcoal tubes should be capped with the supplied plastic caps immediately after sampling. Under no circumstances should rubber caps be used.

8.3.8 With each batch of 10 samples submit one tube from the same lot of tubes which was used for sample collection and which is subjected to exactly the same handling as the samples except that no air is drawn through it. Label this as a blank.

8.3.9 Capped tubes should be packed tightly and padded before they are shipped to minimize tube breakage during shipping.

8.3.10 A sample of the bulk material should be submitted to the laboratory in a glass container with a Teflon-lined cap. This sample should not be transported in the same container as the charcoal tubes.

8.4 Analysis of samples.

8.4.1 Preparation of samples. In preparation for analysis, each charcoal tube is scored with a file in front of the first section of charcoal and broken open. The glass wool is removed and discarded. The charcoal in the first (larger) section is transferred to a 2-ml stoppered sample container. The separating section of foam is removed and discarded; the second section is transferred to another stoppered container. These two sections are analyzed separately.

8.4.2 Desorption of samples. Prior to analysis, 1.0 ml of methanol is pipetted into each sample container. Desorption should be done for 30 minutes. Tests indicate that this is adequate if the sample is agitated occasionally during this period. If an automatic sample injector is used, the sample vials should be capped as soon as the solvent is added to minimize volatilization.

8.4.3 GC conditions. The typical operating conditions for the gas chromatograph are:

1. 50 ml/min (60 psig) nitrogen carrier gas flow.
2. 65 ml/min (24 psig) hydrogen gas flow to detector.
3. 500 ml/min (50 psig) airflow to detector.
4. 235° C injector temperature.
5. 255° C manifold temperature (detector).
6. 155° C column temperature.

8.4.4 Injection. The first step in the analysis is the injection of the sample into the gas chromatograph. To eliminate difficulties arising from blowback or distillation within the syringe needle, one should employ the solvent flush injection technique. The 10-microliter syringe is first flushed with solvent several times to wet the barrel and plunger. Three microliters of solvent are drawn into the syringe to increase the accuracy and reproducibility of the injected sample volume. The needle is removed from the solvent, and the plunger is pulled back about 0.2 microliter to separate the solvent flush from the sample with a pocket of air to be used as a marker. The needle is then immersed in the sample, and a 5-microliter aliquot is withdrawn, taking into consideration the volume of the needle, since the sample in the needle will be completely injected. After the needle is removed from the sample and prior to injection, the plunger is pulled back 1.2 microliters to minimize evaporation of the sample from the tip of the needle. Observe that the sample occupies 4.9-5.0 microliters in the barrel of the syringe. Duplicate injections of each sample and standard should be made. No more than a 3 percent difference in area is to be expected. An automatic sample injector can be used if it is shown to give reproducibility at least as good as the solvent flush method.

8.4.5 Measurement of area. The area of the sample peak is measured by an electronic integrator or some other suitable form of area measurement, and preliminary results are read from a standard curve prepared as discussed below.

8.5 Determination of desorption efficiency.

8.5.1 Importance of determination. The desorption efficiency of a particular compound can vary from one laboratory to another and also from one batch of charcoal to another. Thus, it is necessary to determine at least once the percentage of the specific compound that is removed in the desorption process, provided the same batch of charcoal is used.

8.5.2 Procedure for determining desorption efficiency. Activated charcoal equivalent to the amount in the first section of the sampling tube (100 mg) is measured into a 2.5 in, 4-mm I.D. glass tube, flame sealed at one end. This charcoal must be from the same batch as that used in obtaining the samples and can be obtained from unused charcoal tubes. The open end is capped with Parafilm. A known amount of hexane solution of acrylonitrile containing 0.239 g/ml is injected directly into the activated charcoal with a microliter syringe, and tube is capped with more Parafilm. When using an automatic sample injector, the sample injector vials, capped with Teflon-faced septa, may be used in place of the glass tube. The amount injected is equivalent to that present in a 20-liter air sample at the selected level.

Six tubes at each of three levels (0.5X, 1X, and 2X of the standard) are prepared in this manner and allowed to stand for at least overnight to assure complete adsorption of the analyte onto the charcoal. These tubes are referred to as the sample. A parallel blank tube should be treated in the same manner except that no sample is added to it. The sample and blank tubes are desorbed and analyzed in exactly the same manner as the sampling tube described in section 8.4.

Two or three standards are prepared by injecting the same volume of compound into 1.0 ml of methanol with the same syringe used in the preparation of the samples. These are analyzed with the samples.

The desorption efficiency (D.E.) equals the average weight in mg recovered from the tube divided by the weight in mg added to the tube, or

$$\text{D.E.} = \frac{\text{Average weight recovered (mg)}}{\text{weight added (mg)}}$$

The desorption efficiency is dependent on the amount of analyte collected on the charcoal. Plot the desorption efficiency versus weight of analyte found. This curve is used in section 10.4 to correct for adsorption losses.

9. Calibration and standards.

It is convenient to express concentration of standards in terms of mg/1.0 ml methanol, because samples are desorbed in this amount of methanol. The density of the analyte is used to convert mg into microliters for easy measurement with a microliter syringe. A series of standards, varying in concentration over the range of interest, is prepared and analyzed under the same GC conditions and during the same time period as the unknown samples. Curves are established by plotting concentration in mg/1.0 ml versus peak area.

Note: Since no internal standard is used in the method, standard solutions must be analyzed at the same time that the sample analysis is done. This will minimize the effect of known day-to-day variations and variations during the same day of the FID response.

10. Calculations.

10.1 Read the weight, in mg, corresponding to each peak area from the standard curve. No volume corrections are needed, because the standard curve is based on mg/1.0 ml methanol and the volume of sample injected is identical to the volume of the standards injected.

10.2 Corrections for the blank must be made for each sample.

$$\text{mg} = \text{mg sample} - \text{mg blank}$$

Where:

mg sample = mg found in front section of sample tube.

mg sample = mg found in front section of blank tube.

A similar procedure is followed for the backup sections.

10.3 Add the weights found in the front and backup sections to get the total weight in the sample.

10.4 Read the desorption efficiency from the curve (see sec. 8.5.2) for the amount found in the front section. Divide the total weight by this desorption efficiency to obtain the corrected mg/sample.

$$\text{Corrected mg/sample} = \frac{\text{Total weight}}{\text{D.E.}}$$

10.5 The concentration of the analyte in the air sampled can be expressed in mg/cu m.

$$\text{mg/cu m} = \text{Corrected mg (section 10.4)} \times \frac{1,000 \text{ (liter/cu m)}}{\text{air volume sampled (liter)}}$$

10.6 Another method of expressing concentration is ppm.

$$\text{ppm} = \text{m mg/cu} \times 24.45/\text{M.W.} \times 760/\text{PX T.} + 273/298$$

Where:

P = Pressure (mm Hg) of air sampled.
 T = Temperature (°C) of air sampled.
 24.45 = Molar volume (liter/mole) at 25° C and 760 mm Hg.
 M.W. = Molecular weight (g/mole) of analyte.
 760 = Standard pressure (mm Hg).
 298 = Standard temperature (°K).

11. References.

- 11.1** White, L. D. et al., "A Convenient Optimized Method for the Analysis of Selected Solvent Vapors in the Industrial Atmosphere," Amer. Ind. Hyg. Assoc. J., 31:225 (1970).
11.2 Documentation of NIOSH Validation Tests, NIOSH Contract No. CDC-99-74-45.
11.3 Final Report, NIOSH Contract HSM-99-71-31, "Personal Sampler Pump for Charcoal Tubes," September 15, 1972.

NIOSH Modification of NIOSH Method S-156

The NIOSH recommended method for low levels for acrylonitrile is a modification of method S-156. It differs in the following respects:

- (1) Samples are desorbed using 1 ml of 1 percent acetone in CS(2) rather than methanol.
- (2) The analytical column and conditions are:
 Column: 20 percent SP-1000 on 80/100 Supelcoport 10 feet x 1/8 inch S.S.
 Conditions:
 Injector temperature: 200° C.
 Detector temperature: 100° C.
 Column temperature: 85° C.
 Helium flow: 25 ml/min.
 Air flow: 450 ml/min.
 Hydrogen flow: 55 ml/min.
- (3) A 2 µl injection of the desorbed analyte is used.
- (4) A sampling rate of 100 ml/min is recommended.

OSHA Laboratory Modification of NIOSH Method S-156

Analyte: Acrylonitrile.

Matrix: Air.

Procedure: Adsorption on charcoal, desorption with methanol, GC.

1. Principle of the Method (Reference 1).
 - 1.1 A known volume of air is drawn through a charcoal tube to trap the organic vapors present.
 - 1.2 The charcoal in the tube is transferred to a small, stoppered sample vial, and the analyte is desorbed with methanol.
 - 1.3 An aliquot of the desorbed sample is injected into a gas chromatograph.
 - 1.4 The area of the resulting peak is determined and compared with areas obtained for standards.
2. Advantages and disadvantages of the method.
 - 2.1 The sampling device is small, portable, and involves no liquids. Interferences are minimal, and most of those that do occur can be eliminated by altering chromatographic conditions. The tubes are analyzed by means of a quick, instrumental method.
 - 2.2 This method may not be adequate for the simultaneous analysis of two or more substances.
 - 2.3 The amount of sample that can be taken is limited by the number of milligrams that the tube will hold before overloading. When the sample value obtained for the backup section of the charcoal tube exceeds 25 percent of that found on the front section, the possibility of sample loss exists.
 - 2.4 The precision of the method is limited by the reproducibility of the pressure drop across the tubes. This drop will affect the flow rate and cause the volume to be imprecise, because the pump is usually calibrated for one tube only.
3. Apparatus.
 - 3.1 A calibrated personal sampling pump whose flow can be determined within ± 5 percent at the recommended flow rate.
 - 3.2 Charcoal tubes: Glass tube with both ends flame sealed, 7 cm long with a 6-mm O.D. and a 4-mm I.D., containing 2 sections of 20/40 mesh activated charcoal separated by a 2-mm portion of urethane

foam. The activated charcoal is prepared from coconut shells and is fired at 600 deg. C prior to packing. The adsorbing section contains 100 mg of charcoal, the backup section 50 mg. A 3-mm portion of urethane foam is placed between the outlet end of the tube and the back-up section. A plug of silitated glass wool is placed in front of the adsorbing section. The pressure drop across the tube must be less than one inch of mercury at a flow rate of 1 liter per minute.

3.3 Gas chromatograph equipped with a nitrogen phosphorus detector.

3.4 Column (10-ft x 1/8"-in stainless steel) packed with 100/120 Supelcoport coated with 10 percent SP 1000.

3.5 An electronic integrator or some other suitable method for measuring peak area.

3.6 Two-milliliter sample vials with Teflon-lined caps

3.7 Microliter syringes: 10-microliter, and other convenient sizes for making standards.

3.8 Pipets: 1.0-ml delivery pipets.

3.9 Volumetric flasks: convenient sizes for making standard solutions.

4. Reagents.

4.1 Chromatographic quality methanol.

4.2 Acrylonitrile, reagent grade.

4.3 Filtered compressed air.

4.4 Purified hydrogen.

4.5 Purified helium.

5. Procedure.

5.1 Cleaning of equipment. All glassware used for the laboratory analysis should be properly cleaned and free of organics that could interfere in the analysis.

5.2 Calibration of personal pumps. Each pump must be calibrated with a representative charcoal tube in the line.

5.3 Collection and shipping of samples.

5.3.1 Immediately before sampling, break the ends of the tube to provide an opening at least one-half the internal diameter of the tube (2 mm).

5.3.2 The smaller section of the charcoal is used as the backup and should be placed nearest the sampling pump.

5.3.3 The charcoal should be placed in a vertical position during sampling to minimize channeling through the charcoal.

5.3.4 Air being sampled should not be passed through any hose or tubing before entering the charcoal tube.

5.3.5 A sample size of 20 liters is recommended. Sample at a flow rate of approximately 0.2 liters per minute. The flow rate should be known with an accuracy of at least ± 5 percent.

5.3.6 The temperature and pressure of the atmosphere being sampled should be recorded.

5.3.7 The charcoal tubes should be capped with the supplied plastic caps immediately after sampling. Rubber caps should not be used.

5.3.8 Submit at least one blank tube (a charcoal tube subjected to the same handling procedures, without having any air drawn through it) with each set of samples.

5.3.9. Take necessary shipping and packing precautions to minimize breakage of samples.

5.4 Analysis of samples.

5.4.1 Preparation of samples. In preparation for analysis, each charcoal tube is scored with a file in front of the first section of charcoal and broken open. The glass wool is removed and discarded. The charcoal in the first (larger) section is transferred to a 2-ml vial. The separating section of foam is removed and discarded; the section is transferred to another capped vial. These two sections are analyzed separately.

5.4.2 Desorption of samples. Prior to analysis, 1.0 ml of methanol is pipetted into each sample container. Desorption should be done for 30 minutes in an ultrasonic bath. The sample vials are recapped as soon as the solvent is added.

5.4.3 GC conditions. The typical operating conditions for the gas chromatograph are:

1. 3 ml/min (60 psig) helium carrier gas flow.
2. 3.0 ml/min (30 psig) hydrogen gas flow to detector.
3. 50 ml/min (60 psig) airflow to detector.
4. 200° C injector temperature.
5. 200° C dejector temperature.
7. 100° C column temperature.

5.4.4 Injection. Solvent flush technique or equivalent.

5.4.5 Measurement of area. The area of the sample peak is measured by an electronic integrator or

some other suitable form of area measurement, and preliminary results are read from a standard curve prepared as discussed below.

5.5 Determination of desorption efficiency.

5.5.1 Importance of determination. The desorption efficiency of a particular compound can vary from one laboratory to another and also from one batch of charcoal to another. Thus, it is necessary to determine, at least once, the percentage of the specific compound that is removed in the desorption process, provided the same batch of charcoal is used.

5.5.2 Procedure for determining desorption efficiency. The reference portion of the charcoal tube is removed. To the remaining portion, amounts representing 0.5X, 1X, and 2X (X represents TLV) based on a 20 l air sample are injected onto several tubes at each level. Dilutions of acrylonitrile with methanol are made to allow injection of measurable quantities. These tubes are then allowed to equilibrate at least overnight. Following equilibration they are analyzed following the same procedure as the samples A curve of the desorption efficiency

amt recovered/amt added

is plotted versus amount of analyte found. This curve is used to correct for adsorption losses.

6. Calibration and standards.

A series of standards, varying in concentration over the range of interest, is prepared and analyzed under the same GC conditions and during the same time period as the unknown samples. Curves are prepared by plotting concentration versus peak area.

Note: Since no internal standard is used in the method, standard solutions must be analyzed at the same time that the sample analysis is done. This will minimize the effect of known day-to-day variations and variations during the same day of the NPD response. Multiple injections are necessary.

7. Calculations.

Read the weight, corresponding to each peak area from the standard curve, correct for the blank, correct for the desorption efficiency, and make necessary air volume corrections.

8. Reference. NIOSH Method S-156.

(b) Definitions. As used in 29 CFR section 1910.1045 and applied to this section:

"§1910.20" means section 1910.20 in section 12-202-3.

"§1910.132" means section 1910.132 in section 12-64.1-1.

"§1910.133" means section 1910.133 in section 12-64.1-1.

"§1910.141" means section 1910.141 in chapter 12-67. [Eff 7/6/98] (Auth: HRS §396-4) (Imp: HRS §396-4)

Historical note: §12-202-30.1 is based substantially upon section 12-202-30. [Eff 7/12/82; R 7/6/98]

§12-202-31.1 Inorganic arsenic. (a) Incorporation of federal standard. Title 29 Code of Federal Regulations, section 1910.1018, entitled "Inorganic Arsenic" published by the office of the federal Register. National Archives and Records Administration on May 5, 1978; and the amendments published on June 30, 1978; May 23, 1980; June 2, 1989; June 30, 1993; February 13, 1996; March 2, 1996; January 8, 1998; June 18, 1998; and January 5, 2005, are made a part of this section, except as provided in subsection (b).

§1910.1018 Inorganic arsenic.

(a) Scope and application. This section applies to all occupational exposures to inorganic arsenic except that this section does not apply to employee exposures in agriculture or resulting from pesticide application, the treatment of wood with preservatives or the utilization of arsenically preserved wood.

(b) Definitions.

Action level means a concentration of inorganic arsenic of 5 micrograms per cubic meter of air (5 $\mu\text{g}/\text{m}^3$ averaged over any eight (8) hour period.

Assistant Secretary means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

Authorized person means any person specifically authorized by the employer whose duties require the person to enter a regulated area, or any person entering such an area as a designated representative of employees for the purpose of exercising the right to observe monitoring and measuring procedures under paragraph (e) of this section.

Director means the Director, National Institute for Occupational Safety and Health, U.S. Department of Health and Human Services, or designee.

Inorganic arsenic means copper aceto-arsenite and all inorganic compounds containing arsenic except arsine, measured as arsenic (As).

- (c) Permissible exposure limit. The employer shall assure that no employee is exposed to inorganic arsenic at concentrations greater than 10 micrograms per cubic meter of air (10 ug/m^3 , averaged over any 8-hour period).
- (d) Notification of use.
 - (1) By October 1, 1978 or within 60 days after the introduction of inorganic arsenic into the workplace, every employer who is required to establish a regulated area in his workplaces shall report in writing to the OSHA area office for each such workplace:
 - (i) The address of each such workplace;
 - (ii) The approximate number of employees who will be working in regulated areas; and
 - (iii) A brief summary of the operations creating the exposure and the actions, which the employer intends to take to reduce exposures.
 - (2) Whenever there has been a significant change in the information required by paragraph (d)(1) of this section the employer shall report the changes in writing within 60 days to the OSHA area office.
- (e) Exposure monitoring.
 - (1) General.
 - (i) Determinations of airborne exposure levels shall be made from air samples that are representative of each employee's exposure to inorganic arsenic over an eight (8) hour period.
 - (ii) For the purposes of this section, employee exposure is that exposure which would occur if the employee were not using a respirator.
 - (iii) The employer shall collect full shift (for at least 7 continuous hours) personal samples including at least one sample for each shift for each job classification in each work area.
 - (2) Initial monitoring. Each employer who has a workplace or work operation covered by this standard shall monitor each such workplace and work operation to accurately determine the airborne concentration of inorganic arsenic to which employees may be exposed.
 - (3) Frequency.
 - (i) If the initial monitoring reveals employee exposure to be below the action level the measurements need not be repeated except as otherwise provided in paragraph (e)(4) of this section.
 - (ii) If the initial monitoring, required by this section, or subsequent monitoring reveals employee exposure to be above the permissible exposure limit, the employer shall repeat monitoring at least quarterly.
 - (iii) If the initial monitoring, required by this section, or subsequent monitoring reveals employee exposure to be above the action level and below the permissible exposure limit the employer shall repeat monitoring at least every six months.
 - (iv) The employer shall continue monitoring at the required frequency until at least two consecutive measurements, taken at least seven (7) days apart, are below the action level at which time the employer may discontinue monitoring for that employee until such time as any of the events in paragraph (e)(4) of this section occur.
 - (4) Additional monitoring. Whenever there has been a production, process, control or personal change, which may result in new or additional exposure to inorganic arsenic, or whenever the employer has any other reason to suspect a change, which may result in new or additional exposures to inorganic arsenic, additional monitoring which complies with paragraph (e) of this section shall be conducted.
 - (5) Employee notification.
 - (i) The employer must, within 15 working days after the receipt of the results of any monitoring performed under this section, notify each affected employee of these results either individually in writing or by posting the results in an appropriate location that is accessible to affected employees.
 - (ii) Whenever the results indicate that the representative employee exposure exceeds the permissible exposure limit, the employer shall include in the written notice a statement

that the permissible exposure limit was exceeded and a description of the corrective action taken to reduce exposure to or below the permissible exposure limit.

- (6) Accuracy of measurement.
 - (i) The employer shall use a method of monitoring and measurement which has an accuracy (with a confidence level of 95 percent) of not less than plus or minus 25 percent for concentrations of inorganic arsenic greater than or equal to $10 \mu\text{g}/\text{m}^3$.
 - (ii) The employer shall use a method of monitoring and measurement that has an accuracy (with confidence level of 95 percent) of not less than plus or minus 35 percent for concentrations of inorganic arsenic greater than $5 \mu\text{g}/\text{m}^3$ but less than $10 \mu\text{g}/\text{m}^3$.
- (f) Regulated area.
 - (1) Establishment. The employer shall establish regulated areas where worker exposures to inorganic arsenic, without regard to the use of respirators, are in excess of the permissible limit.
 - (2) Demarcation. Regulated areas shall be demarcated and segregated from the rest of the workplace in any manner that minimizes the number of persons who will be exposed to inorganic arsenic.
 - (3) Access. Access to regulated areas shall be limited to authorized persons or to persons otherwise authorized by the Act or regulations issued pursuant thereto to enter such areas.
 - (4) Provision of respirators. All persons entering a regulated area shall be supplied with a respirator, selected in accordance with paragraph (h)(2) of this section.
 - (5) Prohibited activities. The employer shall assure that in regulated areas, food or beverages are not consumed, smoking products, chewing tobacco and gum are not used and cosmetics are not applied, except that these activities may be conducted in the lunchrooms, change rooms and showers required under paragraph (m) of this section. Drinking water may be consumed in the regulated area.
- (g) Methods of compliance.
 - (1) Controls.
 - (i) The employer shall institute at the earliest possible time but not later than December 31, 1979, engineering and work practice controls to reduce exposures to or below the permissible exposure limit, except to the extent that the employer can establish that such controls are not feasible.
 - (ii) Where engineering and work practice controls are not sufficient to reduce exposures to or below the permissible exposure limit, they shall nonetheless be used to reduce exposures to the lowest levels achievable by these controls and shall be supplemented by the use of respirators in accordance with paragraph (h) of this section and other necessary personal protective equipment. Employee rotation is not required as a control strategy before respiratory protection is instituted.
 - (2) Compliance Program.
 - (i) The employer shall establish and implement a written program to reduce exposures to or below the permissible exposure limit by means of engineering and work practice controls.
 - (ii) Written plans for these compliance programs shall include at least the following:
 - (A) A description of each operation in which inorganic arsenic is emitted; e.g. machinery used, material processed, controls in place, crew size, operating procedures and maintenance practices;
 - (B) Engineering plans and studies used to determine methods selected for controlling exposure to inorganic arsenic;
 - (C) A report of the technology considered in meeting the permissible exposure limit;
 - (D) Monitoring data;
 - (E) A detailed schedule for implementation of the engineering controls and work practices that cannot be implemented immediately and for the adaption and implementation of any additional engineering and work practices necessary to meet the permissible exposure limit;
 - (F) Whenever the employer will not achieve the permissible exposure limit with engineering controls and work practices by December 31, 1979, the employer shall include in the compliance plan an analysis of the effectiveness of the various controls, shall install engineering controls and institute work practices on the quickest schedule feasible, and shall include in the compliance plan and implement a program to minimize the discomfort and maximize the effectiveness of respirator use; and

- (G) Other relevant information.
 - (iii) Written plans for such a program shall be submitted upon request to the Assistant Secretary and the Director, and shall be available at the worksite for examination and copying by the Assistant Secretary, Director, any affected employee or authorized employee representatives.
 - (iv) The plans required by this paragraph must be revised and updated at least annually to reflect the current status of the program.
- (h) Respiratory protection.
- (1) General. For employees who use respirators required by this section, the employer must provide respirators that comply with the requirements of this paragraph. Respirators must be used during:
 - (i) Periods necessary to install or implement feasible engineering work-practice controls.
 - (ii) Work operations, such as maintenance and repair activities, for which the employer establishes that engineering and work-practice controls are not feasible.
 - (iii) Work operations for which engineering and work-practice controls are not yet sufficient to reduce employee exposures to or below the permissible exposure limit.
 - (iv) Emergencies.
 - (2) Respirator program.
 - (i) The employer must implement a respiratory protection program in accordance with 29 CFR 1910.134 (b) through (d) (except (d)(1)(iii)), and (f) through (m).
 - (ii) If an employee exhibits breathing difficulty during fit testing or respirator use, they must be examined by a physician trained in pulmonary medicine to determine whether they can use a respirator while performing the required duty.
 - (3) Respirator selection.
 - (i) The employer must use Table 1 of this section to select the appropriate respirator or combination of respirators for inorganic arsenic compounds without significant vapor pressure, and Table II of this section to select the appropriate respirator or combination of respirators for inorganic arsenic compounds that have significant vapor pressure.
 - (ii) When employee exposures exceed the permissible exposure limit for inorganic arsenic and also exceed the relevant limit for other gases (for example, sulfur dioxide), an air-purifying respirator provided to the employee as specified by this section must have a combination high-efficiency filter with an appropriate gas sorbent. (See footnote in Table 1 of this section.)
 - (iii) Employees required to use respirators may choose, and the employer must provide, a powered air-purifying respirator if it will provide proper protection. In addition, the employer must provide a combination dust and acid-gas respirator to employees who are exposed to gases over the relevant exposure limits.

**TABLE I - RESPIRATORY PROTECTION FOR INORGANIC ARSENIC PARTICULATE
EXCEPT FOR THOSE WITH SIGNIFICANT VAPOR PRESSURE**

Concentration of inorganic arsenic (as As) or condition of use	Required respirator
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Concentration of inorganic arsenic (as As) or condition of use	Required respirator
(i) Unknown or greater or lesser than 20,000 $\mu\text{g}/\text{m}^3$ (20 mg/m^3) or firefighting	(A) Any full facepiece self-contained breathing apparatus operated in positive pressure mode.
(ii) Not greater than 20,000 $\mu\text{g}/\text{m}^3$ (20 mg/m^3).....	(A) Supplied air respirator with full facepiece, hood, or helmet or suit and operated in positive pressure mode.
(iii) Not greater than 10,000 $\mu\text{g}/\text{m}^3$ (10 mg/m^3).....	(A) Powered air-purifying respirators in all inlet face coverings with high efficiency filters ¹ . (B) Half mask supplied air respirators operated in positive pressure mode.
(iv) Not greater than 500 $\mu\text{g}/\text{m}^3$	(A) Full facepiece air purifying respirator equipped with high efficiency filter ¹ . (B) Any full facepiece supplied air respirator. (C) Any full facepiece self-contained breathing apparatus.
(v) Not greater than 100 $\mu\text{g}/\text{m}^3$	(A) Half mask air-purifying respirator equipped with high efficiency filter ¹ . (B) Any half mask supplied air respirator.

¹High-efficiency filter-99.97 pct efficiency against 0.3 micrometer monodisperse diethyl-hexyl phthalate (DOP) particles.

TABLE II-RESPIRATORY PROTECTION FOR INORGANIC ARSENICALS (SUCH AS ARSENIC TRICHLORIDE(2) and Arsenic Phosphide) With Significant Vapor Pressure

Concentration of inorganic arsenic (as As) or condition of use	Required respirator
(i) Unknown or greater or lesser than 20,000 $\mu\text{g}/\text{m}^3$ (20 mg/m^3) or firefighting	(A) Any full facepiece self-contained breathing apparatus operated in positive pressure mode.
(ii) Not greater than 20,000 $\mu\text{g}/\text{m}^3$ (20 mg/m^3).....	(A) Supplied air respirator with full facepiece, hood, or helmet or suit and operated in positive pressure mode.
(iii) Not greater than 10,000 $\mu\text{g}/\text{m}^3$ (10 mg/m^3).....	(A) Half-mask ² supplied air respirator operated in positive pressure mode.
(iv) Not greater than 500 $\mu\text{g}/\text{m}^3$	(A) Front or back mounted gas mask equipped with high-efficiency filter ¹ and acid gas canister. (B) Any full facepiece supplied air respirator. (C) Any full facepiece self-contained breathing apparatus.
(v) Not greater than 100 $\mu\text{g}/\text{m}^3$	(A) Half-mask ² air-purifying respirator equipped - with high-efficiency filter ¹ and acid gas cartridge. (B) Any half-mask supplied air respirator.

¹High-efficiency filter-99.97 pct efficiency against 0.3 micrometer monodisperse diethyl-hexyl phthalate (DOP) particles.

²Half-mask respirators shall not be used for protection against arsenic trichloride, as it is rapidly absorbed through the skin.

(i) [Reserved]

(j) Protective work clothing and equipment.

- (1) Provision and use. Where the possibility of skin or eye irritation from inorganic arsenic exists, and for all workers working in regulated areas, the employer shall provide at no cost to the employee and assure that employees use appropriate and clean protective work clothing and equipment such as, but not limited to:
 - (i) Coveralls or similar full-body work clothing;
 - (ii) Gloves, and shoes or coverlets;
 - (iii) Face shields or vented goggles when necessary to prevent eye irritation, which comply with the requirements of §1910.133(a)(2)-(6); and
 - (iv) Impervious clothing for employees subject to exposure to arsenic trichloride.
- (2) Cleaning and replacement.
 - (i) The employer shall provide the protective clothing required in paragraph (j)(1) of this section in a freshly laundered and dry condition at least weekly, and daily if the employee works in areas where exposures are over $100 \mu\text{g}/\text{m}^3$ of inorganic arsenic or in areas where more frequent washing is needed to prevent skin irritation.
 - (ii) The employer shall clean, launder, or dispose of protective clothing required by paragraph (j)(1) of this section.
 - (iii) The employer shall repair or replace the protective clothing and equipment as needed to maintain their effectiveness.
 - (iv) The employer shall assure that all protective clothing is removed at the completion of a work shift only in change rooms prescribed in paragraph (m)(1) of this section.
 - (v) The employer shall assure that contaminated protective clothing that is to be cleaned, laundered, or disposed of, is placed in a closed container in the change-room that prevents dispersion of inorganic arsenic outside the container.
 - (vi) The employer shall inform in writing any person who cleans or launders clothing required by this section, of the potentially harmful effects including the carcinogenic effects of exposure to inorganic arsenic.
 - (vii) The employer shall assure that the containers of contaminated protective clothing and equipment in the workplace or which are to be removed from the workplace are labeled as follows:

CAUTION: Clothing contaminated with inorganic arsenic; do not remove dust by blowing or shaking. Dispose of inorganic arsenic contaminated wash water in accordance with applicable local, State or Federal regulations.

- (viii) The employer shall prohibit the removal of inorganic arsenic from protective clothing or equipment by blowing or shaking.

(k) House keeping.

- (1) Surfaces. All surfaces shall be maintained as free as practicable of accumulations of inorganic arsenic.
- (2) Cleaning floors. Floors and other accessible surfaces contaminated with inorganic arsenic may not be cleaned by the use of compressed air, and shoveling and brushing may be used only where vacuuming or other relevant methods have been tried and found not to be effective.
- (3) Vacuuming. Where vacuuming methods are selected, the vacuums shall be used and emptied in a manner to minimize the reentry of inorganic arsenic into the workplace.
- (4) Housekeeping plan. A written housekeeping and maintenance plan shall be kept which shall list appropriate frequencies for carrying out housekeeping operations, and for cleaning and maintaining dust collection equipment. The plan shall be available for inspection by the Assistant Secretary.
- (5) Maintenance of equipment. Periodic cleaning of dust collection and ventilation equipment and checks of their effectiveness shall be carried out to maintain the effectiveness of the system and a notation kept of the last check of effectiveness and cleaning or maintenance.

(l) [Reserved]

(m) Hygiene facilities and practices.

- (1) Change rooms. The employer shall provide for employees working in regulated areas or subject to the possibility of skin or eye irritation from inorganic arsenic, clean change rooms equipped with storage facilities for street clothes and separate storage facilities for protective clothing and equipment in accordance with 29 CFR 1910.141(e).
- (2) Showers.

- (i) The employer shall assure that employees working in regulated areas or subject to the possibility of skin or eye irritation from inorganic arsenic shower at the end of the work shift.
 - (ii) The employer shall provide shower facilities in accordance with §1910.141(d)(3).
 - (3) Lunchrooms.
 - (i) The employer shall provide for employees working in regulated areas, lunchroom facilities that have a temperature controlled, positive pressure, filtered air supply, and which are readily accessible to employees working in regulated areas.
 - (ii) The employer shall assure that employees working in the regulated area or subject to the possibility of skin or eye irritation from exposure to inorganic arsenic wash their hands and face prior to eating.
 - (4) Lavatories. The employer shall provide lavatory facilities which comply with §1910.141(d)(1) and (2).
 - (5) Vacuuming clothes. The employer shall provide facilities for employees working in areas where exposure, without regard to the use of respirators, exceeds $100 \mu\text{g}/\text{m}^3$ to vacuum their protective clothing and clean or change shoes worn in such areas before entering change rooms, lunchrooms or shower rooms required by paragraph (j) of this section and shall assure that such employees use such facilities.
 - (6) Avoidance of skin irritation. The employer shall assure that no employee is exposed to skin or eye contact with arsenic trichloride, or to skin or eye contact with liquid or particulate inorganic arsenic which is likely to cause skin or eye irritation.
- (n) Medical surveillance.**
- (1) General.
 - (i) Employees covered. The employer shall institute a medical surveillance program for the following employees:
 - (A) All employees who are or will be exposed above the action level, without regard to the use of respirators, at least 30 days per year; and
 - (B) All employees who have been exposed above the action level, without regard to respirator use, for 30 days or more per year for a total of 10 years or more of combined employment with the employer or predecessor employers prior to or after the effective date of this standard. The determination of exposures prior to the effective date of this standard shall be based upon prior exposure records, comparison with the first measurements taken after the effective date of this standard, or comparison with records of exposures in areas with similar processes, extent of engineering controls utilized and materials used by that employer.
 - (ii) Examination by physician. The employer shall assure that all medical examinations and procedures are performed by or under the supervision of a licensed physician, and shall be provided without cost to the employee, without loss of pay and at a reasonable time and place.
 - (2) Initial examinations. By December 1, 1978, for employees initially covered by the medical provisions of this section, or thereafter at the time of initial assignment to an area where the employee is likely to be exposed over the action level at least 30 days per year, the employer shall provide each affected employee an opportunity for a medical examination, including at least the following elements:
 - (i) A work history and a medical history which shall include a smoking history and the presence and degree of respiratory symptoms such as breathlessness, cough, sputum production and wheezing.
 - (ii) A medical examination that shall include at least the following:
 - (A) A standard posterior-anterior chest x-ray;
 - (B) A nasal and skin examination; and
 - (C) Other examinations that the physician believes appropriate because of the employee's exposure to inorganic arsenic or because of required respirator use.
 - (3) Periodic examinations.
 - (i) Examinations must be provided in accordance with this paragraph at least annually.
 - (ii) The employer shall provide the examinations specified in paragraphs (n)(2)(i) and (n)(2)(ii)(B) and (C) of this section at least semi-annually and the x-ray requirement specified in paragraph (n)(2)(ii)(A) of this section at least annually, for other covered employees.

- (iii) Whenever a covered employee has not taken the examinations specified in paragraphs (n)(2)(i) and (n)(2)(ii) of this section within six (6) months preceding the termination of employment, the employer shall provide such examinations to the employee upon termination of employment.
 - (4) Additional examinations. If the employee for any reason develops signs or symptoms commonly associated with exposure to inorganic arsenic the employer shall provide an appropriate examination and emergency medical treatment.
 - (5) Information provided to the physician. The employer shall provide the following information to the examining physician:
 - (i) A copy of this standard and its appendices;
 - (ii) A description of the affected employee's duties as they relate to the employee's exposure;
 - (iii) The employee's representative exposure level or anticipated exposure level;
 - (iv) A description of any personal protective equipment used or to be used; and
 - (v) Information from previous medical examinations of the affected employee that is not readily available to the examining physician.
 - (6) Physician's written opinion.
 - (i) The employer shall obtain a written opinion from the examining physician that shall include:
 - (A) The results of the medical examination and tests performed;
 - (B) The physician's opinion as to whether the employee has any detected medical conditions that would place the employee at increased risk of material impairment of the employee's health from exposure to inorganic arsenic;
 - (C) Any recommended limitations upon the employee's exposure to inorganic arsenic or upon the use of protective clothing or equipment such as respirators; and
 - (D) A statement that the employee has been informed by the physician of the results of the medical examination and any medical conditions that require further explanation or treatment.
 - (ii) The employer shall instruct the physician not to reveal in the written opinion specific findings or diagnoses unrelated to occupational exposure.
 - (iii) The employer shall provide a copy of the written opinion to the affected employee.
- (o) Employee information and training.
 - (1) Training program.
 - (i) The employer shall institute a training program for all employees who are subject to exposure to inorganic arsenic above the action level without regard to respirator use, or for whom there is the possibility of skin or eye irritation from inorganic arsenic. The employer shall assure that those employees participate in the training program.
 - (ii) The training program shall be provided by October 1, 1978, for employees covered by this provision, at the time of initial assignment for those subsequently covered by this provision, and at least annually for other covered employees thereafter; and the employer shall assure that each employee is informed of the following:
 - (A) The information contained in Appendix A;
 - (B) The quantity, location, manner of use, storage, sources of exposure, and the specific nature of operations which could result in exposure to inorganic arsenic as well as any necessary protective steps;
 - (C) The purpose, proper use, and limitation of respirators;
 - (D) The purpose and a description of the medical surveillance program as required by paragraph (n) of this section;
 - (E) The engineering controls and work practices associated with the employee's job assignment; and
 - (F) A review of this standard.
 - (2) Access to training materials.
 - (i) The employer shall make readily available to all affected employees a copy of this standard and its appendices.
 - (ii) The employer shall provide; upon request, all materials relating to the employee information and training program to the Assistant Secretary and the Director.
- (p) Signs and labels.
 - (1) General.

- (i) The employer may use labels or signs required by other statutes, regulations, or ordinances in addition to, or in combination with, signs and labels required by this paragraph.
 - (ii) The employer shall assure that no statement appears on or near any sign or label required by this paragraph that contradicts or detracts from the meaning of the required sign or label.
- (2) Signs.
- (i) The employer shall post signs demarcating regulated areas bearing the legend;

**DANGER
INORGANIC ARSENIC
CANCER HAZARD
AUTHORIZED PERSONNEL ONLY
NO SMOKING OR EATING
RESPIRATOR REQUIRED**

- (ii) The employer shall assure that signs required by this paragraph are illuminated and cleaned as necessary so that the legend is readily visible.
- (3) Labels. The employer shall apply precautionary labels to all shipping and storage containers of inorganic arsenic, and to all products containing inorganic arsenic except when the inorganic arsenic in the product is bound in such a manner so as to make unlikely the possibility of airborne exposure to inorganic arsenic. (Possible examples of products not requiring labels are semiconductors, light emitting diodes and glass). The label shall bear the following legend:

**DANGER
CONTAINS INORGANIC ARSENIC
CANCER HAZARD
HARMFUL IF INHALED OR SWALLOWED
USE ONLY WITH ADEQUATE VENTILATION
OR RESPIRATORY PROTECTION**

(q) Record Keeping.

- (1) Exposure monitoring.
 - (i) The employer shall establish and maintain an accurate record of all monitoring required by paragraph (e) of this section.
 - (ii) This record shall include:
 - (A) The date(s), number, duration location, and results of each of the samples taken, including a description of the sampling procedure used to determine representative employee exposure where applicable;
 - (B) A description of the sampling and analytical methods used and evidence of their accuracy;
 - (C) The type of respiratory protective devices worn, if any;
 - (D) Name, social security number, and job classification of the employees monitored and of all other employees whose exposure the measurement is intended to represent; and
 - (E) The environmental variables that could affect the measurement of the employee's exposure.
 - (iii) The employer shall maintain these monitoring records for at least 40 years or for the duration of employment plus 20 years, whichever, is longer.
- (2) Medical surveillance.
 - (i) The employer shall establish and maintain an accurate record for each employee subject to medical surveillance as required by paragraph (n) of this section.
 - (ii) This record shall include:
 - (A) The name, social security number, and description of duties of the employee;
 - (B) A copy of the physician's written opinions;
 - (C) Results of any exposure monitoring done for that employee and the representative exposure levels supplied to the physician; and

- (D) Any employee medical complaints related to exposure to inorganic arsenic.
- (iii) The employer shall in addition keep, or assure that the examining physician keeps, the following medical records;
 - (A) A copy of the medical examination results including medical and work history required under paragraph (n) of this section;
 - (B) A description of the laboratory procedures and a copy of any standards or guidelines used to interpret the test results or references to that information;
 - (C) The initial X-ray;
 - (D) The X-rays for the most recent 5 years; and
 - (E) Any X-rays with a demonstrated abnormality and all subsequent X-rays.
- (iv) The employer shall maintain or assure that the physician maintains those medical records for at least 40 years, or for the duration of employment plus 20 years whichever is longer.
- (3) Availability.
 - (i) The employer shall make available upon request all records required to be maintained by paragraph (q) of this section to the Assistant Secretary and the Director for examination and copying.
 - (ii) Records required by this paragraph shall be provided upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.1020(a) through (e) and (g) through (i).
- (4) Transfer of records.
 - (i) Whenever the employer ceases to do business, the successor employer shall receive and retain all records required to be maintained by this section.
 - (ii) Whenever the employer ceases to do business and there is no successor employer to receive and retain the records required to be maintained by this section for the prescribed period, these records shall be transmitted to the Director.
 - (iii) At the expiration of the retention period for the records required to be maintained by this section, the employer shall notify the Director at least 3 months prior to the disposal of such records and shall transmit those records to the Director if he requests them within that period.
 - (iv) The employer shall also comply with any additional requirements involving the transfer of records set in 29 CFR 1910.1020(h).
- (r) Observation of monitoring.
 - (1) Employee observation. The employer shall provide affected employees or their designated representatives an opportunity to observe any monitoring of employee exposure to inorganic arsenic conducted pursuant to paragraph (e) of this section.
 - (2) Observation procedures.
 - (i) Whenever observation of the monitoring of employee exposure to inorganic arsenic requires entry into an area where the use of respirators, protective clothing, or equipment is required, the employer shall provide the observer with and assure the use of such respirators, clothing, and such equipment, and shall require the observer to comply with all other applicable safety and health procedures.
 - (ii) Without interfering with the monitoring, observers shall be entitled to;
 - (A) Receive an explanation of the measurement procedures;
 - (B) Observe all steps related to the monitoring of inorganic arsenic performed at the place of exposure; and
 - (C) Record the results obtained or receive copies of the results when returned by the laboratory.
- (s) Effective date. This standard shall become effective August 1, 1978.
- (t) Appendices. The information contained in the appendices to this section is not intended by itself, to create any additional obligations not otherwise imposed by this standard nor detract from any existing obligation.
- (u) Startup dates.
 - (1) General. The startup dates of requirements of this standard shall be the effective date of this standard unless another startup date is provided for either in other paragraphs of this section or in this paragraph.
 - (2) Monitoring. Initial monitoring shall be commenced on August 1, 1978, and shall be completed by September 15, 1978.

- (3) Regulated areas. Regulated areas required to be established as a result of initial monitoring shall be set up as soon as possible after the results of that monitoring is known and no later than October 1, 1978.
- (4) Compliance program. The written program required by paragraph (g)(2) as a result of initial monitoring shall be made available for inspection and copying as soon as possible and no later than December 1, 1978.
- (5) Hygiene and lunchroom facilities. Construction plans for change- rooms, showers, lavatories, and lunchroom facilities shall be completed no later than December 1, 1978, and these facilities shall be constructed and in use no later than July 1, 1979. However, if as part of the compliance plan it is predicted by an independent engineering firm that engineering controls and work practices will reduce exposures below the permissible exposure limit by December 31, 1979, for affected employees, then such facilities need not be completed until 1 year after the engineering controls are completed or December 31, 1980, whichever is earlier, if such controls have not in fact succeeded in reducing exposure to below the permissible exposure limit.
- (6) Summary of startup dates set forth elsewhere in this standard.

STARTUP DATES

August 1, 1978 - Respirator use over $500 \mu\text{g}/\text{m}^3$.

AS SOON AS POSSIBLE BUT NO LATER THAN

September 15, 1978 - Completion of initial monitoring.

October 1, 1978 - Complete establishment of regulated areas. Respirator use for employees exposed above $50 \mu\text{g}/\text{m}^3$. Completion of initial training. Notification of use.

December 1, 1978 - Respirator use over $10 \mu\text{g}/\text{m}^3$. Completion of initial medical. Completion of compliance plan. Optional use of powered air-purifying respirators.

July 1, 1979 - Completion of lunchrooms and hygiene facilities.

December 31, 1979 - Completion of engineering controls.

All other requirements of the standard have as their startup date August 1, 1978.

APPENDIX A TO §1910.1018 INORGANIC ARSENIC SUBSTANCE INFORMATION SHEET

I. SUBSTANCE IDENTIFICATION

- A. Substance. Inorganic Arsenic.
- B. Definition. Copper acetoarsenite, arsenic and all inorganic compounds containing arsenic except arsine, measured as arsenic (As).
- C. Permissible Exposure Limit. 10 micrograms per cubic meter of air as determined as an average over an 8-hour period. No employee may be exposed to any skin or eye contact with arsenic trichloride or to skin or eye contact likely to cause skin or eye irritation.
- D. Regulated Areas. Only employees authorized by your employer should enter a regulated area.

II. HEALTH HAZARD DATA

- A. Comments. The health hazard of inorganic arsenic is high.
- B. Ways in which the chemical affects your body. Exposure to airborne concentrations of inorganic arsenic may cause lung cancer, and can be a skin irritant. Inorganic arsenic may also affect your body if swallowed. One compound in particular, arsenic trichloride, is especially dangerous because it can be absorbed readily through the skin. Because inorganic arsenic is a poison, you should wash your hands thoroughly prior to eating or smoking.

III. PROTECTIVE CLOTHING AND EQUIPMENT

- A. Respirators. Respirators will be provided by your employer at no cost to you for routine use if your employer is in the process of implementing engineering and work practice controls or where engineering and work practice controls are not feasible or insufficient. You must wear respirators for non-routine activities or in emergency situations where you are likely to be exposed to levels of inorganic arsenic in excess of the permissible exposure limit. Since how well your respirator fits your face is very important, your employer is required to conduct fit tests to make sure the respirator seals properly when you wear it. These tests are simple and rapid and will be explained to you during training sessions.
- B. Protective clothing. If you work in a regulated area, your employer is required to provide at no cost to you, and you must wear, appropriate, clean, protective clothing and equipment. The purpose of this equipment is to prevent you from bringing to your home arsenic-contaminated dust and to protect your body from repeated skin contact with inorganic arsenic likely to cause skin irritation. This clothing should include such items as coveralls or similar full-body clothing, gloves, shoes or coverlets, and aprons. Protective equipment should include face shields or vented goggles, where eye irritation may occur.

IV. HYGIENE FACILITIES AND PRACTICES

You must not eat, drink, smoke, chew gum or tobacco, or apply cosmetics in the regulated area, except that drinking water is permitted. If you work in a regulated area your employer is required to provide lunchrooms and other areas for these purposes.

If you work in a regulated area, your employer is required to provide showers, washing facilities, and change rooms. You must wash your face, and hands before eating and must shower at the end of the work shift. Do not take used protective clothing out of change rooms without your employer's permission. Your employer is required to provide for laundering or cleaning of your protective clothing.

V. SIGNS AND LABELS

Your employer is required to post warning signs and labels for your protection. Signs must be posted in regulated areas. The signs must warn that a cancer hazard is present, that only authorized employees may enter the area, and that no smoking or eating is allowed, and that respirators must be worn.

VI. MEDICAL EXAMINATIONS

If your exposure to arsenic is over the Action Level (5 mg/m³ - (including all persons working in regulated areas) at least 30 days per year, or you have been exposed to arsenic for more than 10 years over the Action Level, your employer is required to provide you with a medical examination. The examination shall be every 6 months for employees over 45 years old or with more than 10 years exposure over the Action Level and annually for other covered employees. The medical examination must include a medical history; a chest x-ray; skin examination and nasal examination. The examining physician will provide a written opinion to your employer containing the results of the medical exams. You should also receive a copy of this opinion. The physician must not tell your employer any conditions he detects unrelated to occupational exposure to arsenic but must tell you those conditions.

VII. OBSERVATION OF MONITORING

Your employer is required to monitor your exposure to arsenic and you or your representatives are entitled to observe the monitoring procedure. You are entitled to receive an explanation of the measurement procedure, and to record the results obtained. When the monitoring procedure is taking place in an area where respirators or personal protective clothing and equipment are required to be worn, you must also be provided with and must wear the protective clothing and equipment.

VIII. ACCESS TO RECORDS

You or your representative is entitled to records of your exposure to inorganic arsenic and your medical examination records if you request your employer to provide them.

IX. TRAINING AND NOTIFICATION

Additional information on all of these items plus training as to hazards of exposure to inorganic arsenic and the engineering and work practice controls associated with your job will also be provided by your employer. If you are exposed over the permissible exposure limit, your employer must inform you of that fact and the actions he is taking to reduce your exposures.

APPENDIX B TO §1910.1018 SUBSTANCE TECHNICAL GUIDELINES

ARSENIC, ARSENIC TRIOXIDE, ARSENIC TRICHLORIDE (THREE EXAMPLES)

I. Physical and chemical properties

- A. Arsenic (metal).
 - 1. Formula: As.
 - 2. Appearance: Gray metal.
 - 3. Melting point: Sublimes without melting at 613C.
 - 4. Specific Gravity: (H₂O=1):5.73.
 - 5. Solubility in water: Insoluble.
- B. Arsenic Trioxide.
 - 1. Formula: As₂O₃, (As₄O₆).
 - 2. Appearance: White powder.
 - 3. Melting point: 315C.
 - 4. Specific Gravity (H₂O=1):3.74.
 - 5. Solubility in water: 3.7 grams in 100cc of water at 20c.
- C. Arsenic Trichloride (liquid).
 - 1. Formula: AsCl₃.
 - 2. Appearance: Colorless or pale yellow liquid.
 - 3. Melting point: -8.5C.

4. Boiling point: 130.2C.
5. Specific Gravity (H₂O=1): 2.16 at 20C.
6. Vapor Pressure: 10mm Hg at 23.5C.
7. Solubility in Water: Decomposes in water.

II. Fire, explosion and reactivity data.

- A. Fire: Arsenic, arsenic Trioxide and Arsenic Trichloride are nonflammable.
- B. Reactivity:
 1. Conditions Contributing to instability: Heat.
 2. Incompatibility: Hydrogen gas can react with inorganic arsenic to form the highly toxic gas arsine.

III. Monitoring and Measurement Procedures

Samples collected should be full shift (at least 7-hour) samples. Sampling should be done using a personal sampling pump at a flow rate of 2 liters per minute. Samples should be collected on 0.8 micrometer pore size membrane filter (37mm diameter). Volatile arsenicals such as arsenic trichloride can be most easily collected in a midjet bubbler filled with 15 ml. of 0.1 N NaOH.

The method of sampling and analysis should have an accuracy of not less than ± 25 percent (with a confidence limit of 95 percent) for 10 micrograms per cubic meter of air (10 $\mu\text{g}/\text{m}^3$) and ± 35 percent (with a confidence limit of 95 percent) for concentrations of inorganic arsenic between 5 and 10 $\mu\text{g}/\text{m}^3$.

APPENDIX C TO §1910.1018 MEDICAL SURVEILLANCE GUIDELINES

I. GENERAL

Medical examinations are to be provided for all employees exposed to levels of inorganic arsenic above the action level (5 $\mu\text{g}/\text{m}^3$) for at least 30 days per year (which would include among others, all employees, who work in regulated areas). Examinations are also to be provided to all employees who have had 10 years or more exposure above the action level for more than 30 days per year while working for the present or predecessor employer though they may no longer be exposed above the level.

An initial medical examination is to be provided to all such employees by December 1, 1978. In addition, an initial medical examination is to be provided to all employees who are first assigned to areas in which worker exposure will probably exceed 5 $\mu\text{g}/\text{m}^3$ (after the effective date of this standard) at the time of initial assignment. In addition to its immediate diagnostic usefulness, the initial examination will provide a baseline for comparing future test results. The initial examination must include as a minimum the following elements:

- (1) A work and medical history, including a smoking history, and presence and degree of respiratory symptoms such as breathlessness, cough, sputum production, and wheezing;
- (2) A 14" by 17" posterior-anterior chest X-ray and an International Labor Office UICC/Cincinnati (ILO U/C) rating;
- (3) A nasal and skin examination; and
- (4) Other examinations that the physician believes appropriate because of the employee's exposure to inorganic arsenic or because of required respirator use.

Periodic examinations are also to be provided to the employees listed above. The periodic examinations shall be given annually for those covered employees 45 years of age or less with fewer than 10 years employment in areas where employee exposure exceeds the action level (5 $\mu\text{g}/\text{m}^3$). Periodic examinations need not include sputum cytology and only an updated medical history is required.

Periodic examinations for other covered employees shall be provided every six (6) months. These examinations shall include all tests required in the initial examination, except that the medical history need only be updated.

The examination contents are minimum requirements. Additional tests such as lateral and oblique X-rays or pulmonary function tests may be useful. For workers exposed to three arsenicals that are associated with lymphatic cancer, copper acetoarsenite, potassium arsenite, or sodium arsenite the

examination should also include palpation of superficial lymph nodes and complete blood count.

II. NONCARCINOGENIC EFFECTS

The OSHA standard is based on minimizing risk of exposed workers dying of lung cancer from exposure to inorganic arsenic. It will also minimize skin cancer from such exposures.

The following three sections quoted from "Occupational Diseases: A Guide to Their Recognition", Revised Edition, June 1977, National Institute for Occupational Safety and Health is included to provide information on the nonneoplastic effects of exposure to inorganic arsenic. Such effects should not occur if the OSHA standards are followed.

- A. Local - Trivalent arsenic compounds are corrosive to the skin. Brief contact has no effect but prolonged contact results in a local hyperemia and later vesicular or pustular eruption. The moist mucous membranes are most sensitive to the irritant action. Conjunctiva, moist and macerated areas of skin, the eyelids, the angles of the ears, nose, mouth, and respiratory mucosa are also vulnerable to the irritant effects. The wrists are common sites of dermatitis, as are the genitalia if personal hygiene is poor. Perforations of the nasal septum may occur. Arsenic trioxide and pentoxide are capable of producing skin sensitization and contact dermatitis. Arsenic is also capable of producing keratoses, especially of the palms and soles.
- B. Systemic - The acute toxic effects of arsenic are generally seen following ingestion of inorganic arsenical compounds. This rarely occurs in an industrial setting. Symptoms develop within 1/2 to 4 hours following ingestion and are usually characterized by constriction of the throat followed by dysphagia, epigastric pain, vomiting, and watery diarrhea. Blood may appear in vomitus and stools. If the amount ingested is sufficiently high, shock may develop due to severe fluid loss, and death may ensue in 24 hours. If the acute effects are survived, exfoliative dermatitis and peripheral neuritis may develop.

Cases of acute arsenical poisoning due to inhalation are exceedingly rare in industry. When it does occur, respiratory tract symptoms-cough, chest pain, dyspnea-giddiness, headache, and extreme general weakness precede gastrointestinal symptoms. The acute toxic symptoms of trivalent arsenical poisoning are due to severe inflammation of the mucous membranes and greatly increased permeability of the blood capillaries.

Chronic arsenical poisoning due to ingestion is rare and generally confined to patients taking prescribed medications. However, it can be a concomitant of inhaled inorganic arsenic from swallowed sputum and improper eating habits. Symptoms are weight loss, nausea and diarrhea alternating with constipation, pigmentation and eruption of the skin, loss of hair, and peripheral neuritis. Chronic hepatitis and cirrhosis have been described. Polyneuritis may be the salient feature, but more frequently there are numbness and parasthenias of "glove and stocking" distribution. The skin lesions are usually melanotic and keratotic and may occasionally take the form of an intradermal cancer of the squamous cell type, but without infiltrative properties. Horizontal white lines (striations) on the fingernails and toenails are commonly seen in chronic arsenical poisoning and are considered to be a diagnostic accompaniment of arsenical polyneuritis.

Inhalation of inorganic arsenic compounds is the most common cause of chronic poisoning in the industrial situation. This condition is divided into three phases based on signs and symptoms.

First Phase: The worker complains of weakness, loss of appetite, some nausea, occasional vomiting, a sense of heaviness in the stomach, and some diarrhea.

Second Phase: The worker complains of conjunctivitis, a catarrhal state of the mucous membranes of the nose, larynx, and respiratory passage. Coryza, hoarseness, and mild tracheobronchitis may occur. Perforation of the nasal septum is common, and is probably the most typical lesion of the upper respiratory tract in occupational exposure to arsenical dust. Skin lesions, eczematoid and allergic in type, are common.

Third Phase: The worker complains of symptoms of peripheral neuritis, initially of hands and feet, which is essentially sensory. In more severe cases, motor paralyses occur; the first muscles affected are usually the toe extensors and the peronei. In only the most severe cases will paralysis of flexor muscles of the feet or of the extensor muscles of hands occur.

Liver damage from chronic arsenical poisoning is still debated, and as yet the question is unanswered. In cases of chronic and acute arsenical poisoning, toxic effects to the myocardium have been reported based on EKG changes. These findings, however, are now largely discounted and the EKG changes are ascribed to electrolyte disturbances concomitant with arsenicalism. Inhalation of arsenic trioxide and other inorganic arsenical dusts does not give rise to radiological evidence or pneumoconiosis. Arsenic does have a depressant effect upon the bone marrow, with disturbances of both

erythropoiesis and myelopoiesis.

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 Vallee, B. L., D. D. Ulmer, and W. E. C. Wacker. 1960. Arsenic toxicology and biochemistry. AMA Arch. Indust. Health 21:132.

(b) Definitions. As used in 29 CFR section 1910.1018 and applied to this section:

- "§1910.20" means section 1910.20 in section 12-202-3.
 "§1910.133" means section 1910.133 in section 12-64.1-1.
 "§1910.134" means section 1910.134 in section 12-64.1-1.
 "§1910.141" means section 1910.141 in chapter 12-67. [Eff 7/6/98; am 3/29/99; am 3/31/06] (Auth: HRS §396-4) (Imp HRS §396-4)

Historical note: §12-202-31.1 is based substantially upon section 12-202-31. [Eff 7/12/82; R 7/6/98]

§12-202-32.1 Cotton dust. (a) Incorporation of federal standard. Title 29 Code of Federal Regulations, section 1910.1043, entitled "Cotton dust" published by the Office of the Federal Register, National Archives and Records Administration on June 23, 1978; and the amendments published on June 30, 1978; August 8, 1978; December 5, 1978; February 26, 1980; May 23, 1980; October 10, 1980; December 13, 1985; July 3, 1986; June 7, 1989; February 13, 1996; January 8, 1998; December 7, 2000 and January 5, 2005, are made a part of this section, except as provided in subsection (b).

§1910.1043 Cotton dust.

(a) Scope and application.

- (1) This section, in its entirety, applies to the control of employee exposure to cotton dust in all workplaces where employees engage in yarn manufacturing, engage in slashing and weaving operations, or work in waste houses for textile operations.
- (2) This section does not apply to the handling or processing of woven or knitted materials; to maritime operations covered by 29 CFR Parts 1915 and 1918; to harvesting or ginning of cotton; or to the construction industry.
- (3) Only paragraphs (h) Medical surveillance, (k)(2) through (4) Record keeping - Medical Records, and Appendices B, C and D of this section apply in all work places where employees exposed to cotton dust engage in cottonseed processing or waste processing operations.
- (4) This section applies to yarn manufacturing and slashing and weaving operations exclusively using washed cotton (as defined by paragraph (n) of this section) only to the extent specified by paragraph (n) of this section.
- (5) This section, in its entirety, applies to the control of all employees exposure to the cotton dust generated in the preparation of washed cotton from opening until the cotton is thoroughly wetted.
- (6) This section does not apply to knitting, classing or warehousing operations except that employers with these operations, if requested by NIOSH, shall grant NIOSH access to their employees and workplaces for exposure monitoring and medical examinations for purposes of a health study to be performed by NIOSH on a sampling basis.

(b) Definitions. For the purpose of this section:

Assistant Secretary means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee;

Blow down means the general cleaning of a room or a part of a room by the use of compressed air.

Blow off means the use of compressed air for cleaning of short duration and usually for a specific machine or any portion of a machine.

Cotton dust means dust present in the air during the handling or processing of cotton, which may contain a mixture of many substances including ground up plant matter, fiber, bacteria, fungi, soil, pesticides, non-cotton plant matter and other contaminants which may have accumulated with the cotton during the growing, harvesting and subsequent processing or storage periods. Any dust present during the handling and processing of cotton through the weaving or knitting of fabrics, and dust present in other operations or manufacturing processes using raw or waste cotton fibers or cotton fiber byproducts from textile mills are considered cotton dust within this definition. Lubricating oil mist associated with weaving operations is not considered cotton dust.

Director means the Director of the National Institute for Occupational Safety and Health (NIOSH), U.S. Department of Health and Human Services, or designee.

Equivalent Instrument means a cotton dust-sampling device that meets the vertical elutriator equivalency requirements as described in paragraph (d)(1)(iii) of this section.

Lint-free respirable cotton dust means particles of cotton dust of approximately 15 micrometers or less aerodynamic equivalent diameter;

Vertical elutriator cotton dust sampler or vertical elutriator means a dust sampler that has a particle size cut-off at approximately 15 micrometers aerodynamic equivalent diameter when operating at the flow rate of 7.4 ± 0.2 liters of air per minute;

Waste processing means waste recycling (sorting, blending, cleaning and willowing) and garneting.

Yarn manufacturing means all textile mill operations from opening to, but not including, slashing and weaving.

(c) Permissible exposure limits and action levels.

(1) Permissible exposure limits (PEL).

- (i) The employer shall assure that no employee who is exposed to cotton dust in yarn manufacturing and cotton washing operations is exposed to airborne concentrations of lint-free respirable cotton dust greater than $200 \mu\text{g}/\text{m}^3$ mean concentration, averaged over an eight-hour period, as measured by a vertical elutriator or an equivalent instrument.
- (ii) The employer shall assure that no employee who is exposed to cotton dust in textile mill waste house operations or is exposed in yarn manufacturing to dust from "lower grade washed cotton" as defined in paragraph (n)(5) of this section is exposed to airborne concentrations of lint-free respirable cotton dust greater than $500 \mu\text{g}/\text{m}^3$ mean concentration, averaged over an eight-hour period, as measured by a vertical elutriator or an equivalent instrument.
- (iii) The employer shall assure that no employee who is exposed to cotton dust in the textile processes known as slashing and weaving is exposed to airborne concentrations of lint-free respirable cotton dust greater than $750 \mu\text{g}/\text{m}^3$ mean concentration, averaged over an eight hour period, as measured by a vertical elutriator or an equivalent instrument.

(2) Action levels.

- (i) The action level for yarn manufacturing and cotton washing operations is an airborne concentration of lint-free respirable cotton dust of $100 \mu\text{g}/\text{m}^3$ mean concentration, averaged over an eight-hour period, as measured by a vertical elutriator or an equivalent instrument.
- (ii) The action level for waste houses for textile operations is an airborne concentration of lint-free respirable cotton dust of $250 \mu\text{g}/\text{m}^3$ mean concentration, averaged over an eight-hour period, as measured by a vertical elutriator or an equivalent instrument.
- (iii) The action level for the textile processes known as slashing and weaving is an airborne concentration of lint-free respirable cotton dust of $375 \mu\text{g}/\text{m}^3$ mean concentration, averaged over an eight-hour period, as measured by a vertical elutriator or an equivalent instrument.

(d) Exposure monitoring and measurement.

(1) General.

- (i) For the purposes of this section, employee exposure is that exposure which would occur if the employee were not using a respirator.
- (ii) The sampling device to be used shall be either the vertical elutriator cotton dust sampler or an equivalent instrument.

- (iii) If an alternative to the vertical elutriator cotton dust sampler is used, the employer shall establish equivalency by reference to an OSHA opinion or by documenting, based on data developed by the employer or supplied by the manufacturer, that the alternative sampling devices meets the following criteria:
 - (A) It collects respirable particulates in the same range as the vertical elutriator (approximately 15 microns);
 - (B) Replicate exposure data used to establish equivalency are collected in side-by-side field and laboratory comparisons; and
 - (C) A minimum of 100 samples over the range of 0.5 to 2 times the permissible exposure limit are collected, and 90% of these samples have an accuracy range of plus or minus 25 per cent of the vertical elutriator reading with a 95% confidence level as demonstrated by a statistically valid protocol. (An acceptable protocol for demonstrating equivalency is described in Appendix E of this section.)
 - (iv) OSHA will issue a written opinion stating that an instrument is equivalent to a vertical elutriator cotton dust sampler if
 - (A) A manufacturer or employer requests an opinion in writing and supplies the following information:
 - (1) Sufficient test data to demonstrate that the instrument meets the requirements specified in this paragraph and the protocol specified in Appendix E of this section;
 - (2) Any other relevant information about the instrument and its testing requested by OSHA; and
 - (3) A certification by the manufacturer or employer that the information supplied is accurate, and
 - (B) if OSHA finds, based on information submitted about the instrument, that the instrument meets the requirements for equivalency specified by paragraph (d) of this section.
 - (2) Initial monitoring. Each employer who has a place of employment within the scope of paragraph (a)(1), (a)(4), or (a)(5) of this section shall conduct monitoring by obtaining measurements which are representative of the exposure of all employees to airborne concentrations of lint-free respirable cotton dust over an eight-hour period. The sampling program shall include at least one determination during each shift for each work area.
 - (3) Periodic monitoring.
 - (i) If the initial monitoring required by paragraph (d)(2) of this section or any subsequent monitoring reveals employee exposure to be at or below the permissible exposure limit, the employer shall repeat the monitoring for those employees at least annually.
 - (ii) If the initial monitoring required by paragraph (d)(2) of this section or any subsequent monitoring reveals employee exposure to be above the PEL, the employer shall repeat the monitoring for those employees at least every six months.
 - (iii) Whenever there has been a production, process, or control change which may result in new or additional exposure to cotton dust, or whenever the employer has any other reason to suspect an increase in employee exposure, the employer shall repeat the monitoring and measurements for those employees affected by the change or increase.
 - (4) Employee notification.
 - (i) The employer must, within 15 working days after the receipt of the results of any monitoring performed under this section, notify each affected employee of these results either individually in writing or by posting the results in an appropriate location that is accessible to employees.
 - (ii) Whenever the results indicate that the employee's exposure exceeds the applicable permissible exposure limit specified in paragraph (c) of this section, the employer shall include in the written notice a statement that the permissible exposure limit was exceeded and a description of the corrective action taken to reduce exposure below the permissible exposure limit.

(e) Methods of compliance.

 - (1) Engineering and work practice controls. The employer shall institute engineering and work practice controls to reduce and maintain employee exposure to cotton dust at or below the permissible exposure limit specified in paragraph (c) of this section, except to the extent that the employer can establish that such controls are not feasible.
 - (2) Whenever feasible engineering and work practice controls are not sufficient to reduce employee exposure to or below the permissible exposure limit, the employer shall nonetheless

- institute these controls to reduce exposure to the lowest feasible level, and shall supplement these controls with the use of respirators which shall comply with the provisions of paragraph (f) of this section.
- (3) Compliance program.
 - (i) Where the most recent exposure monitoring data indicates that any employee is exposed to cotton dust levels greater than the permissible exposure limit, the employer shall establish and implement a written program sufficient to reduce exposures to or below the permissible exposure limit solely by means of engineering controls and work practices as required by paragraph (e)(1) of this section.
 - (ii) The written program shall include at least the following:
 - (A) A description of each operation or process resulting in employee exposure to cotton dust at levels greater than the PEL;
 - (B) Engineering plans and other studies used to determine the controls for each process;
 - (C) A report of the technology considered in meeting the permissible exposure limit;
 - (D) Monitoring data obtained in accordance with paragraph (d) of this section;
 - (E) A detailed schedule for development and implementation of engineering and work practice controls, including exposure levels projected to be achieved by such controls;
 - (F) Work practice program; and
 - (G) Other relevant information.
 - (iii) The employer's schedule as set forth in the compliance program, shall project completion of the implementation of the compliance program no later than March 27, 1984 or as soon as possible if monitoring after March 27, 1984 reveals exposures over the PEL, except as provided in paragraph (m)(2)(ii)(B) of this section.
 - (iv) The employer shall complete the steps set forth in his program by the dates in the schedule.
 - (v) Written programs shall be submitted, upon request, to the Assistant Secretary and the Director, and shall be available at the worksite for examination and copying by the Assistant Secretary, the Director, and any affected employee or their designated representatives.
 - (vi) The written program required under paragraph (e)(3) of this section shall be revised and updated when necessary to reflect the current status of the program and current exposure levels.
 - (4) Mechanical ventilation. When mechanical ventilation is used to control exposure, measurements that demonstrate the effectiveness of the system to control exposure, such as capture velocity, duct velocity, or static pressure shall be made at reasonable intervals.
- (f) Respiratory protection.
- (1) General. For employees who are required to use respirators by this section, the employer must provide respirators that comply with the requirements of this paragraph. Respirators must be used during:
 - (i) Periods necessary to install or implement feasible engineering and work-practice controls.
 - (ii) Maintenance and repair activities for which engineering and work-practice controls are not feasible.
 - (iii) Work operations for which feasible engineering and work-practice controls are not yet sufficient to reduce employee exposure to or below the permissible exposure limits.
 - (iv) Work operations specified under paragraph (g)(1) of this section.
 - (v) Periods for which an employee requests a respirator.
 - (2) Respirator program.
 - (i) The employer must implement a respiratory protection program in accordance with 29 CFR 1910.134 (b) through (d) (except (d)(1)(iii)), and (f) through (m).
 - (ii) Whenever a physician determines that an employee who works in an area in which the cotton-dust concentration exceeds the PEL is unable to use a respirator, including a powered air-purifying respirator, the employee must be given the opportunity to transfer to an available position, or to a position that becomes available later, that has a cotton-dust concentration at or below the PEL. The employer must ensure that such employees retain their current wage rate or other benefits as a result of the transfer.
 - (3) Respirator selection.

- (i) The employer must select the appropriate respirator from Table I of this section.

TABLE I

Cotton dust concentration	Required respirator
Not greater than: (a) 5 x the applicable permissible exposure limit (PEL).	A disposable respirator with a particulate filter.
(b) 10 x the applicable PEL	A quarter or half-mask respirator other than a disposable respirator, equipped with particulate filters.
(c) 100 x the applicable PEL	A full facepiece respirator equipped with high-efficiency particulate filters.
(d) Greater than 100 x the applicable PEL	A POWERED AIR-purifying respirator equipped with high-efficiency particulate filters.

NOTES:

1. A disposable respirator means the filter element is an inseparable part of the respirator.
2. Any respirators permitted at higher environmental concentrations can be used at lower concentrations.
3. Self-contained breathing apparatus are not required respirators but are permitted respirators.
4. Supplied air respirators are not required but are permitted under the following conditions:
Cotton dust concentration not greater than 10X the PEL - Any supplied air respirator; not greater than 100X the PEL - Any supplied air respirator with full facepiece, helmet or hood; greater than 100X the PEL - A supplied air respirator operated in positive pressure mode.

- (ii) Whenever respirators are required by this section for cotton-dust concentrations that do not exceed the applicable permissible exposure limit by a multiple of 100 (100 X), the must, when requested by an employee, provide a powered air-purifying respirator with a high-efficiency particulate filter instead of the respirator specified in paragraphs (a), (b), or (c) of Table I of this section.

- (g) Work practices. Each employer shall, regardless of the level of employee exposure, immediately establish and implement a written program of work practices that shall minimize cotton dust exposure. The following shall be included where applicable:
- (1) Compressed air "blow down" cleaning shall be prohibited where alternative means are feasible. Where compressed air is used for cleaning, the employees performing the "blow down" or "blow off" shall wear suitable respirators. Employees whose presence is not required to perform "blow down" or "blow off" shall be required to leave the area affected by the "blow down" or "blow off" during this cleaning operation.
 - (2) Cleaning of clothing or floors with compressed air shall be prohibited.
 - (3) Floor sweeping shall be performed with a vacuum or with methods designed to minimize dispersal of dust.
 - (4) In areas where employees are exposed to concentrations of cotton dust greater than the permissible exposure limit, cotton and cotton waste shall be stacked, sorted, baled, dumped, removed or otherwise handled by mechanical means, except where the employer can show that it is infeasible to do so. Where infeasible, the method used for handling cotton and cotton waste shall be the method that reduces exposure to the lowest level feasible.
- (h) Medical surveillance.
- (1) General.
 - (i) Each employer covered by the standard shall institute a program of medical surveillance for all employees exposed to cotton dust.
 - (ii) The employer shall assure that all medical examinations and procedures are performed by or under the supervision of a licensed physician and are provided without cost to the employee.
 - (iii) Persons other than licensed physicians, who administer the pulmonary function testing required by this section shall have completed a NIOSH-approved training course in

spirometry.

- (2) Initial examinations. The employer shall provide medical surveillance to each employee who is or may be exposed to cotton dust. For new employees, this examination shall be provided prior to initial assignment. The medical surveillance shall include at least the following:
 - (i) A medical history;
 - (ii) The standardized questionnaire contained in Appendix B; and
 - (iii) A pulmonary function measurement, including a determination of forced vital capacity (FVC) and forced expiratory volume in one second (FEV₁), the FEV₁/FVC ratio, and the percentage that the measured values of FEV₁ and FVC differ from the predicted values, using the standard tables in Appendix C. These determinations shall be made for each employee before the employee enters the workplace on the first day of the work week, preceded by at least 35 hours of no exposure to cotton dust. The tests shall be repeated during the shift, no less than 4 and no more than 10 hours after the beginning of the work shift; and, in any event, no more than one hour after cessation of exposure. Such exposure shall be typical of the employee's usual workplace exposure. The predicted FEV₁ and FVC for blacks shall be multiplied by 0.85 to adjust for ethnic differences.
 - (iv) Based upon the questionnaire results, each employee shall be graded according to Schilling's byssinosis classification system.
- (3) Periodic examinations.
 - (i) The employer shall provide at least annual medical surveillance for all employees exposed to cotton dust above the action level in yarn manufacturing, slashing and weaving, cotton washing and waste house operations. The employer shall provide medical surveillance at least every two years for all employees exposed to cotton dust at or below the action level, for all employees exposed to cotton dust from washed cotton (except from washed cotton defined in paragraph (n)(3) of this section), and for all employees exposed to cotton dust in cottonseed processing and waste processing operations. Periodic medical surveillance shall include at least an update of the medical history, standardized questionnaire (App. B-111), Schilling byssinosis grade, and the pulmonary function measurements in paragraph (h)(2)(iii) of this section.
 - (ii) Medical surveillance as required in paragraph (h)(3)(i) of this section shall be provided every six months for all employees in the following categories:
 - (A) An FEV₁ of greater than 80 percent of the predicted value, but with an FEV₁ decrement of 5 percent or 200 ml. on a first working day;
 - (B) An FEV₁ of less than 80 percent of the predicted value; or
 - (C) Where, in the opinion of the physician, any significant change in questionnaire findings, pulmonary function results, or other diagnostic tests have occurred.
 - (iii) An employee whose FEV₁ is less than 60 percent of the predicted value shall be referred to a physician for a detailed pulmonary examination.
 - (iv) A comparison shall be made between the current examination results and those of previous examinations and a determination made by the physician as to whether there has been a significant change.
- (4) Information provided to the physician. The employer shall provide the following information to the examination physician:
 - (i) A copy of this regulation and its Appendices;
 - (ii) A description of the affected employee's duties as they relate to the employee's exposure;
 - (iii) The employee's exposure level or anticipated exposure level;
 - (iv) A description of any personal protective equipment used or to be used; and
 - (v) Information from previous medical examinations of the affected employee that is not readily available to the examining physician.
- (5) Physician's written opinion.
 - (i) The employer shall obtain and furnish the employee with a copy of a written opinion from the examining physician containing the following:
 - (A) The results of the medical examination and tests including the FEV₁, FVC, AND FEV₁/FVC ratio;
 - (B) The physician's opinion as to whether the employee has any detected medical conditions which would place the employee at increased risk of material impairment of the employee's health from exposure to cotton dust;
 - (C) The physician's recommended limitations upon the employee's exposure to cotton

- dust or upon the employee's use of respirators including a determination of whether an employee can wear a negative pressure respirator, and where the employee cannot, a determination of the employee's ability to wear a powered air purifying respirator; and,
- (D) A statement that the employee has been informed by the physician of the results of the medical examination and any medical conditions that require further examination or treatment.
- (ii) The written opinion obtained by the employer shall not reveal specific findings or diagnoses unrelated to occupational exposure.
- (i) Employee education and training.
- (1) Training program.
- (i) The employer shall provide a training program for all employees exposed to cotton dust and shall assure that each employee is informed of the following:
- (A) The acute and long term health hazards associated with exposure to cotton dust;
- (B) The names and descriptions of jobs and processes that could result in exposure to cotton dust at or above the PEL.
- (C) The measures, including work practices required by paragraph (g) of this section, necessary to protect the employee from exposures in excess of the permissible exposure limit;
- (D) The purpose, proper use and limitations of respirators required by paragraph (f) of this section;
- (E) The purpose for and a description of the medical surveillance program required by paragraph (h) of this section and other information which will aid exposed employees in understanding the hazards of cotton dust exposure; and
- (F) The contents of this standard and its appendices.
- (ii) The training program shall be provided prior to initial assignment and shall be repeated annually for each employee exposed to cotton dust, when job assignments or work processes change and when employee performance indicates a need for retraining.
- (2) Access to training materials.
- (i) Each employer shall post a copy of this section with its appendices in a public location at the workplace, and shall, upon request, make copies available to employees.
- (ii) The employer shall provide all materials relating to the employee training and information program to the Assistant Secretary and the Director upon request.
- (j) Signs. The employer shall post the following warning sign in each work area where the permissible exposure limit for cotton dust is exceeded:

WARNING
COTTON DUST WORK AREA
MAY CAUSE ACUTE OR DELAYED
LUNG INJURY
(BYSSINOSIS)
RESPIRATORS
REQUIRED IN THIS AREA

- (k) Record Keeping.
- (1) Exposure measurements.
- (i) The employer shall establish and maintain an accurate record of all measurements required by paragraph (d) of this section.
- (ii) The record shall include:
- (A) A log containing the items listed in paragraph IV (a) of Appendix A, and the dates, number, duration, and results of each of the samples taken, including a description of the procedure used to determine representative employee exposure;
- (B) The type of protective devices worn, if any, and length of time worn; and
- (C) The names, social security numbers, job classifications, and exposure levels of employees whose exposure the measurement is intended to represent.
- (iii) The employer shall maintain this record for at least 20 years.
- (2) Medical surveillance.
- (i) The employer shall establish and maintain an accurate medical record for each employee subject to medical surveillance required by paragraph (h) of this section.
- (ii) The record shall include:

- (A) The name and social security number and description of the duties of the employee;
 - (B) A copy of the medical examination results including the medical history, questionnaire response, results of all tests, and the physician's recommendation;
 - (C) A copy of the physician's written opinion;
 - (D) Any employee medical complaints related to exposure to cotton dust;
 - (E) A copy of this standard and its appendices, except that the employer may keep one copy of the standard and the appendices for all employees, provided that he references the standard and appendices in the medical surveillance record of each employee; and
 - (F) A copy of the information provided to the physician as required by paragraph (h)(4) of this section.
- (iii) The employer shall maintain this record for at least 20 years.
- (3) Availability.
 - (i) The employer shall make all records required to be maintained by paragraph (k) of this section available to the Assistant Secretary and the Director for examination and copying.
 - (ii) Employee exposure measurement records and employee medical records required by this paragraph shall be provided upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.20 (a) through (e) and (g) through (i).
 - (4) Transfer of records.
 - (i) Whenever the employer ceases to do business, the successor employer shall receive and retain all records required to be maintained by paragraph (k) of this section.
 - (ii) Whenever the employer ceases to do business, and there is no successor employer to receive and retain the records for the prescribed period, these records shall be transmitted to the Director.
 - (iii) At the expiration of the retention period for the records required to be maintained by this section, the employer shall notify the Director at least 3 months prior to the disposal of such records and shall transmit those records to the Director if the Director requests them within that period.
 - (iv) The employer shall also comply with any additional requirements involving transfer of records set forth in 29 CFR 1910.20(h).
- (l) Observation of monitoring.
 - (1) The employer shall provide affected employees or their designated representatives an opportunity to observe any measuring or monitoring of employee exposure to cotton dust conducted pursuant to paragraph (d) of this section.
 - (2) Whenever observation of the measuring or monitoring of employee exposure to cotton dust requires entry into an area where the use of personal protective equipment is required, the employer shall provide the observer with and assure the use of such equipment and shall require the observer to comply with all other applicable safety and health procedures.
 - (3) Without interfering with the measurement, observers shall be entitled to:
 - (i) An explanation of the measurement procedures;
 - (ii) An opportunity to observe all steps related to the measurement of airborne concentrations of cotton dust performed at the place of exposure; and,
 - (iii) An opportunity to record the results obtained.
 - (m) Effective date.
 - (1) General. This section is effective March 27, 1980, except as otherwise provided below.
 - (2) Startup dates.
 - (i) Initial monitoring. The initial monitoring required by paragraph (d)(2) of this section shall be completed as soon as possible but no later than March 27, 1980.
 - (ii) Methods of compliance: engineering and work practice controls.
 - (A) The engineering and work practice controls required by paragraph (e) of this section shall be implemented no later than March 27, 1984 except as set forth in paragraph (m)(2)(ii)(B) of this section.
 - (B) The engineering and work practice controls required by paragraph (e) of this section shall be implemented no later than March 27, 1986, for ring spinning operations (including only ring spinning and winding, twisting, spooling, beaming and warping following ring spinning) where the operations meet the following criteria:
 - (1) The weight of the yarn being run is 100 percent cotton and the average yarn count by weight is 18 or below;

- (2) The average weight of the yarn run is 80 percent or more cotton and the average yarn count by weight is 16 or below; or
 - (3) The average weight of the yarn being run is 50 percent or more cotton and the average yarn count by weight is 14 or below.
- (C) When the provisions of paragraph (m)(2)(ii)(B) of this section are being relied upon, the following definitions shall apply:
 - (1) The average cotton content shall be determined by dividing the total weight of cotton in the yarns being run by the total weight of all the yarns being run in the relevant work area.
 - (2) The average yarn count shall be determined by multiplying the yarn count times the pounds of each particular yarn being run to get the "total hank" for each of the yarns being run in the relevant area. The "total hank" values for all of the yarns being run should then be summed and divided by the total pounds of yarn being run, to produce the average yarn count number for all the yarns being run in the relevant work area.
- (D) Where the provisions of paragraph (m)(2)(ii)(B) of this section are being relied upon, the employer shall update the employer's compliance plan no later than February 13, 1986 to indicate the steps being taken to reduce cotton dust levels to 200 $\mu\text{g}/\text{m}^3$ through the use of engineering and work practice controls by March 27, 1986.
- (E) Where the provisions of paragraph (m)(2)(ii)(B) of the section are being relied upon, the employer shall maintain airborne concentrations of cotton dust below 1000 $\mu\text{g}/\text{m}^3$ mean concentration averaged over an eight-hour period measured by a vertical elutriator or an equivalent instrument with engineering accuracy and precision with engineering and work practice controls and shall maintain the permissible exposure limit specified by paragraph (c)(1)(i) of this section with any combination of engineering controls, work practice controls and respirators.
- (iii) Compliance program. The compliance program required by paragraph (e)(3) of this section shall be established no later than March 27, 1981.
- (iv) Respirators. The respirators required by paragraph (f) of this section shall be provided no later than April 27, 1980.
- (v) Work practices. The work practices required by paragraph (g) of this section shall be implemented no later than June 27, 1980.
- (vi) Medical surveillance. The medical surveillance required by paragraph (h) of this section shall be completed no later than March 27, 1981 for the textile industry and no later than June 13, 1986 for the cottonseed processing and waste processing industry.
- (vii) Employee education and training. The initial education and training required by paragraph (i) of this section shall be completed as soon as possible but no later than June 27, 1980.
- (3) Amendments. The amendments to this section published on December 13, 1985 become effective on February 11, 1986. If the amendments are not in effect because of stays of enforcement or judicial decisions, the provisions published in 29 CFR 1910.1043 as of July 1, 1985 are effective.
- (n) Washed Cotton.**
 - (1) Exemptions. Cotton, after it has been washed by the processes described in this paragraph, is exempt from all or parts of this section as specified if the requirements of this paragraph are met.
 - (2) Initial requirements.
 - (i) In order for an employer to qualify as exempt or partially exempt from this standard for operations using washed cotton, the employer must demonstrate that the cotton was washed in a facility which is open to inspection by the Assistant Secretary and the employer must provide sufficient accurate documentary evidence to demonstrate that the washing methods utilized meet the requirements of this paragraph.
 - (ii) An employer who handles or processes cotton which has been washed in a facility not under the employer's control and claims an exemption or partial exemption under this paragraph, must obtain from the cotton washer and make available at the worksite, to the Assistant Secretary, to any affected employee, or to their designated representative the following:
 - (A) A certification by the washer of the cotton of the grade of cotton, the type of washing process, and that the batch meets the requirements of this paragraph;

- (B) Sufficient accurate documentation by the washer of the cotton grades and washing process; and,
 - (C) An authorization by the washer that the Assistant Secretary or the Director may inspect the washer's washing facilities and documentation of the process.
- (3) Medical and dyed cotton. Medical grade (USP) cotton, cotton that has been scoured, bleached and dyed, and mercerized yarn shall be exempt from all provisions of this standard.
- (4) Higher grade washed cotton. The handling or processing of cotton classed as "low middling light spotted or better" (color grade 52 or better and leaf grade code 5 or better according to the 1993 USDA classification system) shall be exempt from all provisions of the standard except the requirements of paragraph (h) medical surveillance, (k)(2) through (4) record keeping—medical records, and Appendices B, C, and D of this section, if they have been washed on one of the following systems:
 - (i) On a continuous batt system or a rayon rinse system including the following conditions:
 - (A) With water;
 - (B) At a temperature of no less than 60 °C;
 - (C) With a water-to-fiber ratio of no less than 40:1; and
 - (D) With the bacterial levels in the wash water controlled to limit bacterial contamination of the cotton.
 - (ii) On a batch kier washing system including the following conditions:
 - (A) With water;
 - (B) With cotton fiber mechanically opened and thoroughly pre-wetted before forming the cake;
 - (C) For low-temperature processing, at a temperature of no less than 60 °C with a water-to-fiber ratio of no less than 40:1; or, for high-temperature processing, at a temperature of no less than 93 °C with a water-to-fiber ratio of no less than 15:1;
 - (D) With a minimum of one wash cycle followed by two rinse cycles for each batch, using fresh water in each cycle, and
 - (E) With bacterial levels in the wash water controlled to limit bacterial contamination of the cotton.
- (5) Lower grade washed cotton. The handling and processing of cotton of grades lower than "low middling light spotted," that has been washed as specified in paragraph (n)(4) of this section and has also been bleached, shall be exempt from all provisions of the standard except the requirements of paragraphs (c)(1)(ii) Permissible Exposure Limit, (d) Exposure Monitoring, (h) Medical Surveillance, (k) Record Keeping, and Appendices B, C and D of this section.
- (6) Mixed grades of washed cotton. If more than one grade of washed cotton is being handled or processed together, the requirements of the grade with the most stringent exposure limit, medical and monitoring requirements shall be followed.
- (o) Appendices.
 - (1) Appendices B, C, and D of this section are incorporated as part of this section and the contents of these appendices are mandatory.
 - (2) Appendix A of this section contains information that is not intended to create any additional obligations not otherwise imposed or to detract from any existing obligations.
 - (3) Appendix E of this section is a protocol that may be followed in the validation of alternative measuring devices as equivalent to the vertical elutriator cotton dust sampler. Other protocols may be used if it is demonstrated that they are statistically valid, meet the requirements in paragraph (d)(1)(iii) of this section, and are appropriate for demonstrating equivalency.

APPENDIX A to §1910.1043 AIR SAMPLING AND ANALYTICAL PROCEDURES FOR DETERMINING CONCENTRATIONS OF COTTON DUST

I. SAMPLING LOCATIONS

The sampling procedures must be designed so that samples of the actual dust concentrations are collected accurately and consistently and reflect the concentrations of dust at the place and time of sampling. Sufficient number of 6-hour area samples in each distinct work area of the plant should be collected at locations, which provide representative samples of air to which the worker is exposed. In order to avoid filter-overloading, sampling time may be shortened when sampling in dusty areas.

Samples in each work area should be gathered simultaneously or sequentially during a normal operating period. The daily time-weighted average (TWA) exposure of each worker can then be determined by using the following formula:

Summation of hours spent in each location and the dust concentration in that location.

Total hours exposed

A time-weighted average concentration should be computed for each worker and properly logged and maintained on file for review.

II. SAMPLING EQUIPMENT

(a) **Sampler.** The instrument selected for monitoring is the Lumsden-Lynch vertical elutriator. It should operate at a flow rate of 7.4 ± 0.2 liters/minute.

The samplers should be cleaned prior to sampling. The pumps should be monitored during sampling.

(b) **Filter Holder.** A three-piece cassette constructed of polystyrene designed to hold a 37-mm diameter filter should be used. Care must be exercised to insure that an adequate seal exists between elements of the cassette.

(c) **Filters and Support Pads.** The membrane filters used should be polyvinyl chloride with a 5- μ m pore size and 37-mm diameter. A support pad, commonly called a backup pad, should be used under the filter membrane in the field monitor cassette.

(d) **Balance.** A balance sensitive to 10 micrograms should be used.

(e) **Monitoring equipment for use in Class III hazardous locations** must be approved for use in such locations, in accordance with the requirements of the OSHA electrical standards in Subpart S of Part 1910.

III. INSTRUMENT CALIBRATION PROCEDURE

Samplers shall be calibrated when first received from the factory, after repair, and after receiving any abuse. The samplers should be calibrated in the laboratory both before they are used in the field and after they have been used to collect a large number of field samples. The primary standard, such as a spirometer or other standard calibrating instruments such as a wet test meter or a large bubble meter or dry gas meter, should be used. Instructions for calibration with the wet test meter follow. If another calibration device is selected, equivalent procedures should be used:

(a) **Level wet test meter.** Check the water level that should just touch the calibration point at the left side of the meter. If water level is low, add water 1-2° F. warmer than room temperature of till point. Run the meter for 30 minutes before calibration;

(b) Place the polyvinyl chloride membrane filter in the filter cassette;

(c) Assemble the calibration sampling train;

(d) Connect the wet test meter to the train.

The pointer on the meter should run clockwise and a pressure drop of not more than 1.0 inch of water indicated. If the pressure drop is greater than 1.0, disconnect and check the system;

(e) Operate the system for ten minutes before starting the calibration;

(f) Check the vacuum gauge on the pump to insure that the pressure drop across the orifice exceeds 17 inches of mercury;

(g) Record the following on calibration data sheets:

- (1) Wet test meter reading, start and finish;
- (2) Elapsed time, start and finish (at least two minutes);
- (3) Pressure drop at manometer;
- (4) Air temperature;
- (5) Barometric pressure; and,
- (6) Limiting orifice number;

(h) Calculate the flow rate and compare against the flow of 7.4 ± 0.2 liters/minute. If flow is between these limits, perform calibration again, average results, and record orifice number and flow rate. If flow is not within these limits, discard or modify orifice and repeat procedure;

(i) Record the name of the person performing the calibration, the date, serial number of the wet test meter, and the number of the critical orifices being calibrated.

IV. SAMPLING PROCEDURE

- (a)** Sampling data sheets should include a log of:
 - (1) The date of the sample collection;
 - (2) The time of sampling;
 - (3) The location of the sampler;
 - (4) The sampler serial number;
 - (5) The cassette number;
 - (6) The time of starting and stopping the sampling and the duration of sampling;
 - (7) The weight of the filter before and after sampling;
 - (8) The weight of dust collected (corrected for controls);
 - (9) The dust concentration measured;
 - (10) Other pertinent information; and
 - (11) Name of person taking sample
- (b)** Assembly of filter cassette should be as follows:
 - (1) Loosely assemble 3-piece cassette;
 - (2) Number cassette;
 - (3) Place absorbent pad in cassette;
 - (4) Weigh filter to an accuracy of 10 µg;
 - (5) Place filter in cassette;
 - (6) Record weight of filter in log, using cassette number for identification;
 - (7) Fully assemble cassette, using pressure to force parts tightly together;
 - (8) Install plugs top and bottom;
 - (9) Put shrink band on cassette, covering joint between center and bottom parts of cassette; and,
 - (10) Set cassette aside until shrink band dries thoroughly.
- (c)** Sampling collection should be performed as follows:
 - (1) Clean lint out of the motor and elutriator;
 - (2) Install vertical elutriator in sampling locations specified above with inlet 4 1/2 to 5 1/2 feet from floor (breathing zone height);
 - (3) Remove top section of cassette;
 - (4) Install cassette in ferrule of elutriator;
 - (5) Tape cassette to ferrule with masking tape or similar material for airtight seal;
 - (6) Remove bottom plug of cassette and attach hose containing critical orifice;
 - (7) Start elutriator pump and check to see if gauge reads above 17 in. of Hg vacuum;
 - (8) Record starting time, cassette number, and sampler number;
 - (9) At end of sampling period stop pump and record time; and,
 - (10) Controls with each batch of samples collected, two additional filter cassettes should be subjected to exactly the same handling as the samples, except that they are not opened. These control filters should be weighed in the same manner as the sample filters. Any difference in weight in the control filters would indicate that the procedure for handling sample filters may not be adequate and should be evaluated to ascertain the cause of the difference, whether and what necessary corrections must be made, and whether additional samples must be collected.
- (d)** Shipping. The cassette with samples should be collected, along with the appropriate number of blanks, and shipped to the analytical laboratory in a suitable container to prevent damage in transit.
- (e)** Weighing of the sample should be achieved as follows:
 - (1) Remove shrink band;
 - (2) Remove top and middle sections of cassette and bottom plug;
 - (3) Remove filter from cassette and weigh to an accuracy of 10 µg; and,
 - (4) Record weight in log against original weight.
- (f)** Calculation of volume of air sampled should be determined as follows:
 - (1) From starting and stopping times of sampling period, determine length of time in minutes of sampling period; and,
 - (2) Multiply sampling time in minutes by flow rate of critical orifice in liters per minute and divide by 1000 to find air quantity in cubic meters.
- (g)** Calculation of Dust Concentrations should be made as follows:
 - (1) Subtract weight of clean filter from dirty filter and apply control correction to find actual weight of sample. Record this weight (in µg) in log; and
 - (2) Divide mass of sample in µg by air volume in cubic meters to find dust concentration in µg/m. Record in log.

APPENDIX B-I RESPIRATORY QUESTIONNAIRE

A.IDENTIFICATION DATA

PLANT _____ SOCIAL SECURITY NO. _____
 DAY MONTH YEAR
 (figures) (last 2 digits)

NAME _____ DATE OF INTERVIEW _____
 (Surname)
 _____ DATE OF BIRTH _____
 (First Names)

ADDRESS _____ AGE _____ (8.9) SEX M F (10)
 _____ RACE _____ (11)

INTERVIEWER: 1 2 3 4 5 6 7 8 (12)

WORK SHIFT: 1st _____ 2nd _____ 3rd _____ (13) STANDING HEIGHT _____ (14.15)

PRESENT WORK AREA _____ WEIGHT _____ (16.18)

If working in more than one specified work area, X area where most of the workshift is spent. If "other", but spending 25% of the workshift in one of the specified work areas, classify in that work area. If carding department employee, check area within that department where most of the work shift is spent (if in doubt, check "throughout"). For work areas such as spinning and weaving where many work rooms may be involved, be sure to check the specific work room to which employee is assigned--if he works in more than one work room within a department classify as 7 (all) for that department.

		(19)	(20)		(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)
	Work-room #	Open	Pick	Area	Card #1	#2	Spin	Wind	Twist	Spool	Warp	Slash	Weave	Other
AT RISK (cotton & cotton blend)	1			Cards										
	2			Draw										
	3			Comb										
	4			Rove										
	5			Thru Out										
	6													
	7 (all)													
Control (synthetic & wool)	8													

Ex-Worker (cotton)	9													
-----------------------	---	--	--	--	--	--	--	--	--	--	--	--	--	--

Use actual wording of each question. Put X in appropriate square after each question. When in doubt record "No". When no square, circle appropriate answer.

B. COUGH

(on getting up)≠

Do you usually cough first thing in the morning?

Yes ___ No ___ (31)

(Count a cough with first smoke or on "first going out of doors." Exclude clearing throat or a single cough.)

Do you usually cough during the day or at night?

Yes ___ No ___ (32)

(Ignore an occasional cough.)

If "Yes" to either question (31-32):

Do you cough like this on most days for as much as three months a year?

Yes ___ No ___ (33)

Do you cough on any particular day of the week?

Yes ___ No ___ (34)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	
If "Yes": Which day?	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Sun.	(35)

C. PHLEGM or alternative word to suit local custom.

(on getting up)≠

Do you usually bring up any phlegm from your chest first thing in the morning?

Yes ___ No ___ (36)

(Count phlegm with the first smoke or on "first going out of doors." Exclude phlegm from the nose. Count swallowed phlegm.)

Do you usually bring up any phlegm from your chest during the day or at night? (Accept twice or more.)

Yes ___ No ___ (37)

If "Yes" to either question (36) or (37):

Do you bring up phlegm like this on most days for as much as three months each year?

Yes ___ No ___ (38)

If "Yes" to question (33) or (38):

(cough)

(1) ≡ 2 years or less (39)

How long have you had this phlegm?

(2) ≡ More than 2 years-9 years

(Write in number of years)

(3) ≡ 10-19 years

(4) ≡ 20+ years

≠These words are for subjects who work at night

D. CHEST ILLNESSES

In the past three years, have you had a period of (increased) \neq cough and phlegm lasting for 3 weeks or more?

(1) \Rightarrow No (40)

(2) \Rightarrow Yes, only one period

(3) \Rightarrow Yes, two or more periods

\neq For subjects who usually have phlegm

During the past 3 years have you had any chest illness which has kept you off work, indoors at home or in bed? (For as long as one week, flu?)

Yes __ No __ (41)

If "Yes" to (41): Did you bring up (more) phlegm illnesses? than usual in any of these

Yes __ No __ (42)

If "Yes" to (42): During the past three years have you had: Only one such illness with increased phlegm?

(1) \Rightarrow (43)

More than one such illness:

(2) \Rightarrow (44)

Br. Grade _____

E. TIGHTNESS

Does your chest ever feel tight or your breathing become difficult?

Yes __ No __ (45)

Is your chest tight or your breathing difficult on any particular day of the week? (after a week or 10 days away from the mill)

Yes __ No __ (46)

If "Yes": Which day?

(1) \nearrow Mon \nwarrow (3) Tues (4) Wed (5) Thur (6) Fri (7) Sat (8) Sun.
 Sometimes Always

(47)

If "Yes" Monday: At what time on Monday does your chest feel tight or your breathing difficult?

(1) \Rightarrow Before entering the mill (48)

(2) \Rightarrow After entering the mill

(Ask only if NO to Question (45))

In the past, has your chest ever been tight or your breathing difficult on any particular day of the week?

Yes __ No __ (49)

If "Yes": Which day?

(1) \nearrow Mon \nwarrow (3) Tues (4) Wed (5) Thur (6) Fri (7) Sat (8) Sun.
 Sometimes Always

(50)

F. BREATHLESSNESS

If disabled from walking by any condition other than heart

or lung disease, put "X" here and leave questions (52-60) unasked.

(51)

Are you ever troubled by shortness of breath when hurrying on the level or walking up a slight hill?

Yes ____ No ____ (52)

If "No", grade is 1. If "Yes", proceed to next question.

Do you get short of breath walking with other people at an ordinary pace on the level?

Yes ____ No ____ (53)

If "No", grade is 2. If "Yes", proceed to next question.

Do you have to stop for breath when walking at your own pace on the level?

Yes ____ No ____ (54)

If "No", grade is 3. If "Yes", proceed to next question.

Are you short of breath on washing or dressing?

Yes ____ No ____ (55)

If "No", grade is 4. If "Yes", grade is 5.

Dyspnea Grd. ____ (56)

ON MONDAYS:

Are you ever troubled by shortness of breath when hurrying on the level or walking up a slight hill?

Yes ____ No ____ (57)

If "No", grade is 1. If "Yes", proceed to next question.

Do you get short of breath walking with other people at an ordinary pace on the level?

Yes ____ No ____ (58)

If "No", Grade is 2. If "Yes", proceed to next question.

Do you have to stop for breath when walking at your own pace on the level?

Yes ____ No ____ (59)

If "No", grade is 3. If "Yes", proceed to next question.

Are you short of breath on washing or dressing?

Yes ____ No ____ (60)

If "No", grade is 4. If "Yes", grade is 5.

B. Grd. _____ (61)

G. OTHER ILLNESSES AND ALLERGY HISTORY

Do you have a heart condition for which you are under a doctor's care?

Yes ____ No ____ (62)

Have you ever had asthma?

Yes ____ No ____ (63)

If "Yes", did it begin:

(1) ☐ Before age 30

(2) ☐ After age 30

If "Yes" before 30: Did you have asthma before ever going to work in a textile mill?

Yes ___ No ___ (64)

Have you ever had hay fever or other allergies (other than above)?

Yes ___ No ___ (65)

H. TOBACCO SMOKING*

Do you smoke?

Record "Yes" if regular smoker up to one month ago.
(Cigarettes, cigars, or pipe)

Yes ___ No ___ (66)

If "No" to (63):

Have you ever smoked? (Cigarettes, cigars, pipe.
Record "No" if subject has never smoked as much as
one cigarette a day, or 1 oz. of tobacco a month,
for as long as one year.)

Yes ___ No ___ (67)

If "Yes" to (63) or (64): What have you smoked and for how many years?
(Write in specific number of years in the appropriate square.)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Years	(<5)	(5-9)	(10-14)	(15-19)	(20-24)	(25-29)	(30-34)	(35-39)	(>40)
Cigarettes									
Pipe									
Cigars									

(68)

(69)

(70)

If cigarettes, how many packs a day?
(Write in number of cigarettes)

(1) ☐ Less than 1/2 pack (71)

(2) ☐ 1/2 pack, but less than 1 pack

(3) ☐ 1 pack, but less than 1-1/2 packs

(4) ☐ 1-1/2 packs or more

Number of pack years:

_____ (72, 73)

If an ex-smoker (cigarettes, cigars, or pipe), how long since you stopped? (Write in number of years.)

_____ (74)

(1) ☐ 0-1 year

(2) ☐ 1-4 years

(3) ☐ 5-9 years

(4) ≡ 10+ years

*Have you changed your smoking habits since last interview? If yes, specify what changes.

I. OCCUPATIONAL HISTORY**

Have you every worked in:

A foundry? (As long as one year) Yes ___ No ___ (75)

Stone or mineral mining, quarrying or processing?
(As long as one year) Yes ___ No ___ (76)

Asbestos milling or processing (Ever) Yes ___ No ___ (77)

Other dusts, fumes, or smoke? Yes ___ No ___ (78)

If "Yes", specify:

Type of exposure _____

Length of exposure _____

**Ask only on first interview.

At what age did you first go to work in a textile mill? (Write in specific age in appropriate square.)

(1)	(2)	(3)	(4)	(5)	(6)
<20	20-24	25-29	30-34	35-39	40+

When you first worked in a textile mill,
did you work with:

(1) ☐ Cotton or cotton blend (79)

(2) ☐ Synthetic or wool (80)

APPENDIX B-II

Respiratory Questionnaire For Non-Textile Workers for the Cotton Industry

Identification No.

Interviewer Code

Location

Date of Interview

A. IDENTIFICATION

1. NAME (Last) (first) (Middle Initial)		2. PHONE NUMBER AREA CODE () NO.	4. SOCIAL SECURITY (optional see below) _____
2. CURRENT ADDRESS (Number, Street, or Rural Route. City or town. County. State. Zip Code)		5. BIRTH DATE	6. AGE LAST BIRTHDAY
		7. SEX a. <input type="checkbox"/> Male b. <input type="checkbox"/> Female	
		8. ETHNIC GROUP OR ANCESTRY a. <input type="checkbox"/> White, not Hispanic Origin b. <input type="checkbox"/> Black, not of Hispanic origin c. <input type="checkbox"/> Hispanic d. <input type="checkbox"/> American Indian or Alaskan native e. <input type="checkbox"/> Asian or Pacific Islander f. <input type="checkbox"/> Other: _____	
9. STANDING HEIGHT _____(Cm)	10. WEIGHT _____	11. WORK SHIFT 1 ST <input type="checkbox"/> 2 ND <input type="checkbox"/> 3 RD <input type="checkbox"/>	
12. PRESENT WORK AREA Please indicate primary assigned work area and percent of time spent at that site. If at other locations, please indicate and note percent of time for each.			

PRIMARY WORK AREA	
SPECIFIC JOB	
13. APPROPRIATE INDUSTRY 1 <input type="checkbox"/> Garnetting 3 <input type="checkbox"/> Cotton Warehouse 5 <input type="checkbox"/> Cotton Classification 2 <input type="checkbox"/> Cotton Oil Mill 4 <input type="checkbox"/> Utilization 6 <input type="checkbox"/> Cotton Ginning	
(Furnishing your Social Security number is voluntary. Your refusal to provide this number will not affect any right, benefit, or privilege to which you would be entitled if you did provide your Social Security Number. Your Social Security number is being requested since it will permit use in future determinations in statistical research studies.)	

B. OCCUPATIONAL HISTORY TABLE

Complete the following table showing the entire work history of the individual from present to initial employment. Sporadic, part-time periods of employment, each of no significant duration, should be grouped if possible.

[illegible]

C. SYMPTOMS

Use actual wording of each question. Put X in appropriate square after each question. When in doubt record "No".

COUGH

1. Do you usually cough first thing in the morning?
(on getting up)* 1 ☐ Yes 2 ☐ No
(Count a cough with first smoke or on "first going out Of doors". Exclude clearing throat or a single cough.)
2. Do you usually cough during the day or at night?
(Ignore an occasional cough.) 1 ☐ Yes 2 ☐ No

If YES to either question 1 or 2:

3. Do you cough like this on most days for as much as three months a year? 1 ☐ Yes 2 ☐ No 9 ☐ NA
4. Do you cough on any particular day of the week? 1 ☐ Yes 2 ☐ No

If YES:

5. Which day? Mon. Tue. Wed. Thur. Fri. Sat. Sun.

PHLEGM

6. Do you usually bring up any phlegm from your chest first thing in the morning? (on getting up)* 1 ☐ Yes 2 ☐ No
(Count phlegm with the first smoke or on "first going out of doors." Exclude phlegm from the nose. Count swallowed phlegm.)
7. Do you usually bring up any phlegm from your chest during the day or at night? (Accept twice or more.) 1 ☐ Yes 2 ☐ No

If YES to either question 6 or 7:

8. Do you bring up phlegm like this on most days for as much as three months each year? 1 ☐ Yes 2 ☐ No

If YES to question 3 or 8:

9. How long have you had this phlegm? (cough)
(Write in number of years) (1) ☐ 2 years or less
(2) ☐ More than 2 years - 9 years

(3) ☐ 10-19 years(4) ☐ 20+ years

*These words are for subjects who work at night

CHEST ILLNESS

10. In the past three years, have you had a period of (increased) cough and phlegm only one period

(1) ☐ No
 (2) ☐ Yes, lasting for 3 weeks or more?
 (3) ☐ Yes, two or more periods

For subjects who usually have phlegm:

11. During the past 3 years have you had any chest illness which has kept you off work, indoors at home or in bed? (For as long as one week, flu?)

1 ☐ Yes 2 ☐ No

If YES to 11:

12. Did you bring up (more) phlegm than usual in any of these illnesses?

1 ☐ Yes 2 ☐ No

If YES to 12: During the past three years have you had:

13. Only one such illness with increased phlegm?

1 ☐ Yes 2 ☐ No

14. More than one such illness:

1 ☐ Yes 2 ☐ No

Br. Brade _____

TIGHTNESS

15. Does your chest ever feel tight or your breathing become difficult?

1 ☐ Yes 2 ☐ No

16. Is your chest tight or your breathing difficult on any particular day of the week? (after a week or 10 days away from the mill)

1 ☐ Yes 2 ☐ No

If "Yes": Which day?		(3)	(4)	(5)	(6)	(7)	(8)
	Mon	Tues	Wed	Thur	Fri	Sat	Sun.
	(1)	(2)					
	Sometimes	Always					

18. If YES Monday: At what time on Monday does your feel tight or chest your breathing difficult?

☐ Before entering mill
☐ After entering mill

(ASK ONLY IF NO TO QUESTION 15)

19. In the past, has your chest ever been tight or your breathing difficult on any particular day of the week? 1 = Yes 2 = No

		(3)	(4)	(5)	(6)	(7)	(8)
If "Yes": Which day?	Mon	Tues	Wed	Thur	Fri	Sat	Sun.
	(1) Sometimes	(2) Always					

BREATHLESSNESS

21. If disabled from walking by any condition other than heart or lung disease put "X" in the space and leave questions (22-30) unasked. ☐
22. Are you ever troubled by shortness of breath when hurrying on the level or walking up a slight hill? 1 ☐ Yes 2 ☐ No

If NO, grade is 1. If YES, proceed to next question

23. Do you get short of breath walking with other people at an ordinary pace on the level? 1 ☐ Yes 2 ☐ No

If NO, grade is 2. If YES, proceed to next question

24. Do you have to stop for breath when walking at your own pace on the level? 1 ☐ Yes 2 ☐ No

If NO, grade is 3. If YES, proceed to next question

25. Are you short of breath on washing or dressing? 1 ☐ Yes 2 ☐ No

If NO, grade is 4. If YES, grade is 5.

- | | |
|-----|--------------|
| 26. | Dyspnea Grd. |
|-----|--------------|

ON MONDAYS:

27. Are you ever troubled by shortness of breath, when hurrying on the level or walking up a slight hill? 1 ☐ Yes 2 ☐ No

If NO, grade is 1. If YES, proceed to next question

28. Do you get short of breath walking with other people at an ordinary pace on the level? 1 = Yes 2 = No

If NO, grade is 2. If YES, proceed to next question

29. Do you have to stop for breath when walking at your own pace on the level? 1 ☐ Yes 2 ☐ No

If NO, grade is 3. If YES, proceed to next question

30. Are you short of breath on washing or dressing? 1 ☐ Yes 2 ☐ No

If NO, grade is 4. If YES, grade is 5.

31. B. Grd. _____

OTHER ILLNESSES AND ALLERGY HISTORY

32. Do you have a heart condition for which you are under a doctor's care? 1 ☐ Yes 2 ☐ No

OTHER ILLNESSES AND ALLERGY HISTORY CONTINUED:

33. Have you ever had asthma? 1 ☐ Yes 2 ☐ No
If YES, did it begin: (1) ☐ Before age 30
(2) ☐ After age 30

34. If Yes before 30: did you have asthma before ever going to work in a textile mill? 1 ☐ Yes 2 ☐ No

35. Have you ever had hay fever or other allergies (other than above)? 1 ☐ Yes 2 ☐ No

TOBACCO SMOKING

36. Do you smoke? Record YES if regular smoker up to one month ago. (Cigarettes, cigars, or pipe) 1 ☐ Yes 2 ☐ No

If NO to (33).

37. Have you ever smoked? (Cigarettes, cigars, pipe. Record NO if subject has never smoked as much as one cigarette a day, or 1 oz. of tobacco a month, for as long as one year.) 1 ☐ Yes 2 ☐ No

If YES to (33) or (34); what have you smoked for how many years? (Write in specific number of years in the appropriate square)

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Years	(<5)	(5-9)	(10-14)	(15-19)	(20-24)	(25-29)	(30-34)	(35-29)	(>40)
38.	Cigarettes									
39.	Pipe									
40.	Cigars									

41. If cigarettes, how many packs per day?
Write in number of cigarettes
- (1) ☐ Less than 1/2 pack
 (2) ☐ 1/2 pack, but less than 1 pack
 (3) ☐ 1 pack, but less than 1-1/2 packs
 (4) ☐ 1-1/2 packs or more
42. Number of pack years:
43. If an ex-smoker (cigarettes, cigar, or pipe), how long since you stopped? (Write in number of years.)
- (1) ☐ 0-1 year
 (2) ☐ 1-4 years
 (3) ☐ 5-9 years
 (4) ☐ 10+ years

OCCUPATIONAL HISTORY

Have you ever worked in:

44. A foundry? (As long as one year) 1 ☐ Yes 2 ☐ No
45. Stone or mineral mining, quarrying or processing? (As long as one year) 1 ☐ Yes 2 ☐ No
46. Asbestos milling or processing? (Ever) 1 ☐ Yes 2 ☐ No
47. Cotton or cotton blend mill? (For controls only) 1 ☐ Yes 2 ☐ No
48. Other dusts, fumes, or smoke? If yes, specify. 1 ☐ Yes 2 ☐ No

Type of exposure _____

Length of exposure _____

APPENDIX B-III
ABBREVIATED RESPIRATORY QUESTIONNAIRE

A. IDENTIFICATION DATA

PLANT _____ SOCIAL SECURITY NO. _____
 DAY MONTH YEAR
 (figures) (last 2 digits)

NAME _____ DATE OF INTERVIEW _____
 (Surname)

_____ DATE OF BIRTH _____
 (First Names)

ADDRESS _____ AGE _____ (8.9) SEX ☐ M ☐ F (10)

 w n ind. other

RACE _____ (11)

INTERVIEWER: 1 2 3 4 5 6 7 8 (12)

WORK SHIFT: 1st _____ 2nd _____ 3rd _____(13) STANDING HEIGHT _____ (14.15)

PRESENT WORK AREA _____ WEIGHT _____ (16.18)

If working in more than one specified work area, X area where most of the workshift is spent. If "other", but spending 25% of the workshift in one of the specified work areas, classify in that work area. If carding department employee, check area within that department where most of the work shift is spent (if in doubt, check "throughout"). For work areas such as spinning and weaving where many work rooms may be involved, be sure to check the specific work room to which employee is assigned--if he works in more than one work room within a department classify as 7 (all) for that department.

		(19)	(20)		(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)
	Work-room #	Open	Pick	Area	Card #1	#2	Spin	Wind	Twist	Spool	Warp	Slash	Weave	Other
AT RISK (cotton & cotton blend)	1			Cards										
	2			Draw										
	3			Comb										
	4			Rove										
	5			Thru Out										
	6													
	7 (all)													
Control (synthetic & wool)	8													
Ex-Worker (cotton)	9													

Use actual wording of each question. Put X in appropriate square after each question. When in doubt record "No". When no square, circle appropriate answer.

B. COUGH

(on getting up)≠

Do you usually cough first thing in the morning?
(Count a cough with first smoke or on "first going out of doors." Exclude clearing throat or a single cough.)

Yes ____ No ____ (31)

Do you usually cough during the day or at night?

Yes ____ No ____ (32)

If YES to either question (31-32):

Do you cough like this on most days for as much as

Yes ____ No ____ (33)

Do you cough on any particular day of the week?

Yes ____ No ____ (34)

If "Yes": Which day? (1) Mon (2) Tues (3) Wed (4) Thur (5) Fri (6) Sat (7) Sun. (35)

C. PHLEGM or alternative word to suit local custom.

Do you usually bring up any phlegm from your chest first thing in the morning? (Count phlegm with the first smoke or on "first going out of doors." Exclude phlegm from the nose. Count swallowed phlegm.) Yes ____ No ____ (36)

Do you usually bring up any phlegm from your chest during the day or at night? (Accept twice or more.) Yes ____ No ____ (37)

If "Yes" to either question (36) or (37):

Do you bring up phlegm like this on most days for as much as three months each year? Yes ____ No ____ (38)

If "Yes" to question (33) or (38):
(cough)

How long have you had this phlegm
(Write in number of years)

- (1) = 2 years or less
(2) = More than 2 years-9 years
(3) = 10-19 years
(4) = 20+ years

≠These words are for subjects who work at night

D. TIGHTNESS

Does your chest ever feel tight or your breathing become difficult? Yes ____ No ____ (39)

Is your chest tight or your breathing difficult on any particular day of the week? (after a week or 10 days away from the mill) Yes ____ No ____ (40)

If "Yes": Which day?	Mon	(3) Tues	(4) Wed	(5) Thur	(6) Fri	(7) Sat	(8) Sun.	(41)
	(1) Sometimes	(2) Always						

If "Yes" Monday: At what time on Monday does your chest feel tight or your breathing difficult?

- 1 = Before entering the mill (42)
2 = After entering the mill

(Ask only if NO to Question (45))

In the past, has your chest ever been tight or your breathing difficult on any particular day of the week? Yes ____ No ____ (43)

If "Yes": Which day?	Mon	(3) Tues	(4) Wed	(5) Thur	(6) Fri	(7) Sat	(8) Sun.	(44)
	(1) Sometimes	(2) Always						

E. TOBACCO SMOKING*

*Have you changed your smoking habits since last interview? If "Yes", specify what changes.

APPENDIX C--Spirometry Prediction Tables For Normal Males and Females

HT	AGE		TABLE 1. PREDICTED FVC FOR MALES (Knudson, Et Al. AM REV RESPIR DIS. 1976, 113, 587.																							
	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61	63	65	
60.0	3.44	3.59	3.75	3.91	3.72	3.66	3.61	3.55	3.49	3.43	3.37	3.32	3.26	3.20	3.14	3.08	3.03	2.97	2.91	2.85	2.79	2.74	2.68	2.62	2.56	
60.5	3.50	3.66	3.81	3.97	3.80	3.75	3.69	3.63	3.57	3.51	3.46	3.40	3.34	3.28	3.22	3.17	3.11	3.05	2.99	2.93	2.88	2.82	2.76	2.70	2.64	
61.0	3.56	3.72	3.88	4.03	3.89	3.83	3.77	3.71	3.66	3.60	3.54	3.48	3.42	3.37	3.31	3.25	3.19	3.13	3.08	3.02	2.96	2.90	2.84	2.79	2.73	
61.5	3.63	3.70	3.94	4.10	3.97	3.91	3.85	3.80	3.74	3.68	3.62	3.56	3.51	3.45	3.39	3.33	3.27	3.22	3.16	3.10	3.04	2.98	2.93	2.87	2.81	
62.0	3.69	3.85	4.00	4.16	4.05	3.99	3.94	3.88	3.82	3.76	3.70	3.65	3.59	3.53	3.47	3.41	3.36	3.30	3.24	3.18	3.12	3.07	3.01	2.95	2.89	
62.5	3.76	3.91	4.07	4.22	4.13	4.08	4.02	3.96	3.90	3.84	3.79	3.73	3.67	3.61	3.55	3.50	3.44	3.38	3.32	3.26	3.21	3.15	3.09	3.03	2.97	
63.0	3.82	3.97	4.13	4.29	4.22	4.16	4.10	4.04	3.99	3.93	3.87	3.81	3.75	3.70	3.64	3.58	3.52	3.46	3.41	3.35	3.29	3.23	3.17	3.12	3.06	
63.5	3.88	4.04	4.19	4.35	4.30	4.24	4.18	4.13	4.07	4.01	3.95	3.89	3.84	3.78	3.72	3.66	3.60	3.55	3.49	3.43	3.37	3.31	3.26	3.20	3.14	
64.0	3.95	4.10	4.26	4.41	4.38	4.32	4.27	4.21	4.15	4.09	4.03	3.98	3.92	3.86	3.80	3.74	3.69	3.63	3.57	3.51	3.45	3.40	3.34	3.28	3.22	
64.5	4.01	4.17	4.32	4.48	4.46	4.41	4.35	4.29	4.23	4.17	4.12	4.06	4.00	3.94	3.88	3.83	3.77	3.71	3.65	3.59	3.54	3.48	3.42	3.36	3.30	
65.0	4.07	4.23	4.39	4.54	4.55	4.49	4.43	4.37	4.32	4.26	4.20	4.14	4.08	4.03	3.97	3.91	3.85	3.79	3.74	3.68	3.62	3.56	3.50	3.45	3.39	
65.5	4.14	4.29	4.45	4.60	4.63	4.57	4.51	4.46	4.40	4.34	4.28	4.22	4.17	4.11	4.05	3.99	3.93	3.88	3.82	3.76	3.70	3.64	3.59	3.53	3.47	
66.0	4.20	4.36	4.51	4.67	4.71	4.65	4.60	4.54	4.48	4.42	4.36	4.31	4.25	4.19	4.13	4.07	4.02	3.96	3.90	3.84	3.78	3.73	3.67	3.61	3.55	
66.5	4.26	4.42	4.58	4.73	4.80	4.74	4.68	4.62	4.56	4.51	4.45	4.39	4.33	4.27	4.22	4.16	4.10	4.04	3.98	3.93	3.87	3.81	3.75	3.69	3.64	
67.0	4.33	4.48	4.64	4.80	4.88	4.82	4.76	4.70	4.65	4.59	4.53	4.47	4.41	4.36	4.30	4.24	4.18	4.12	4.07	4.01	3.95	3.89	3.83	3.78	3.72	
67.5	4.39	4.55	4.70	4.86	4.96	4.90	4.84	4.79	4.73	4.67	4.61	4.55	4.50	4.44	4.38	4.32	4.26	4.21	4.15	4.09	4.03	3.97	3.92	3.86	3.80	
68.0	4.45	4.61	4.77	4.92	5.04	4.98	4.93	4.87	4.81	4.75	4.69	4.64	4.58	4.52	4.46	4.40	4.35	4.29	4.23	4.17	4.11	4.06	4.00	3.94	3.88	
68.5	4.52	4.67	4.83	4.99	5.13	5.07	5.01	4.95	4.89	4.84	4.78	4.72	4.66	4.60	4.55	4.49	4.43	4.37	4.31	4.26	4.20	4.14	4.08	4.02	3.97	
69.0	4.58	4.74	4.89	5.05	5.21	5.15	5.09	5.03	4.98	4.92	4.86	4.80	4.74	4.69	4.63	4.57	4.51	4.45	4.40	4.34	4.28	4.22	4.16	4.11	4.05	
69.5	4.64	4.80	4.96	5.11	5.29	5.23	5.17	5.12	5.06	5.00	4.94	4.88	4.83	4.77	4.71	4.65	4.59	4.54	4.48	4.42	4.36	4.30	4.25	4.19	4.13	
70.0	4.71	4.86	5.02	5.18	5.37	5.32	5.26	5.20	5.14	5.08	5.02	4.97	4.91	4.85	4.79	4.74	4.68	4.62	4.56	4.50	4.44	4.39	4.33	4.27	4.21	
70.5	4.77	4.93	5.08	5.24	5.46	5.40	5.34	5.28	5.22	5.17	5.11	5.05	4.99	4.93	4.88	4.82	4.76	4.70	4.64	4.59	4.53	4.47	4.41	4.35	4.30	
71.0	4.83	4.99	5.15	5.30	5.54	5.48	5.42	5.36	5.31	5.25	5.19	5.13	5.07	5.02	4.96	4.90	4.84	4.78	4.73	4.67	4.61	4.55	4.49	4.44	4.38	
71.5	4.90	5.05	5.21	5.37	5.62	5.56	5.50	5.45	5.39	5.33	5.27	5.21	5.16	5.10	5.04	4.98	4.92	4.87	4.81	4.75	4.69	4.63	4.58	4.52	4.46	
72.0	4.96	5.12	5.27	5.43	5.70	5.65	5.59	5.53	5.47	5.41	5.36	5.30	5.24	5.18	5.12	5.07	5.01	4.95	4.89	4.83	4.78	4.72	4.66	4.60	4.54	
72.5	5.03	5.18	5.34	5.49	5.79	5.73	5.67	5.61	5.55	5.50	5.44	5.38	5.32	5.26	5.21	5.15	5.09	5.03	4.97	4.92	4.86	4.80	4.74	4.68	4.63	
73.0	5.09	5.24	5.40	5.56	5.87	5.81	5.75	5.69	5.64	5.58	5.52	5.46	5.40	5.35	5.29	5.23	5.17	5.11	5.06	5.00	4.94	4.88	4.82	4.77	4.71	
73.5	5.15	5.31	5.46	5.62	5.95	5.89	5.83	5.78	5.72	5.66	5.60	5.54	5.49	5.43	5.37	5.31	5.25	5.20	5.14	5.08	5.02	4.96	4.91	4.85	4.79	
74.0	5.22	5.37	5.53	5.68	6.03	5.98	5.92	5.86	5.80	5.74	5.69	5.63	5.57	5.51	5.45	5.40	5.34	5.28	5.22	5.16	5.11	5.05	4.99	4.93	4.87	
74.5	5.28	5.44	5.59	5.75	6.12	6.06	6.00	5.94	5.88	5.83	5.77	5.71	5.65	5.59	5.54	5.48	5.42	5.36	5.30	5.25	5.19	5.13	5.07	5.01	4.96	
75.0	5.34	5.50	5.65	5.81	6.20	6.14	6.08	6.02	5.97	5.91	5.85	5.79	5.73	5.68	5.62	5.56	5.50	5.44	5.39	5.33	5.27	5.21	5.15	5.10	5.04	
75.5	5.41	5.56	5.72	5.87	6.28	6.22	6.17	6.11	6.05	5.99	5.93	5.88	5.82	5.76	5.70	5.64	5.59	5.53	5.47	5.41	5.35	5.30	5.24	5.18	5.12	
76.0	5.47	5.63	5.78	5.94	6.36	6.31	6.25	6.19	6.13	6.07	6.02	5.96	5.90	5.84	5.78	5.73	5.67	5.61	5.55	5.49	5.44	5.38	5.32	5.26	5.20	
76.5	5.53	5.69	5.85	6.00	6.45	6.39	6.33	6.27	6.21	6.16	6.10	6.04	5.98	5.92	5.87	5.81	5.75	5.69	5.63	5.58	5.52	5.46	5.40	5.34	5.29	
77.0	5.60	5.75	5.91	6.06	6.53	6.47	6.41	6.35	6.30	6.24	6.18	6.12	6.06	6.01	5.95	5.89	5.83	5.77	5.72	5.66	5.60	5.54	5.48	5.43	5.37	
77.5	5.66	5.82	5.97	6.13	6.61	6.55	6.50	6.44	6.38	6.32	6.26	6.21	6.15	6.09	6.03	5.97	5.92	5.86	5.80	5.74	5.68	5.63	5.57	5.51	5.45	
78.0	5.72	5.88	6.04	6.19	6.69	6.64	6.58	6.52	6.46	6.40	6.35	6.29	6.23	6.17	6.11	6.06	6.00	5.94	5.88	5.82	5.77	5.71	5.65	5.59	5.53	
78.5	5.79	5.94	6.10	6.26	6.78	6.72	6.66	6.60	6.54	6.49	6.43	6.37	6.31	6.25	6.20	6.14	6.08	6.02	5.96	5.91	5.85	5.79	5.73	5.67	5.62	
79.0	5.85	6.01	6.16	6.32	6.86	6.80	6.74	6.68	6.63	6.57	6.51	6.45	6.39	6.34	6.28	6.22	6.16	6.10	6.05	5.99	5.93	5.87	5.81	5.76	5.70	
79.5	5.91	6.07	6.23	6.38	6.94	6.88	6.83	6.77	6.71	6.65	6.59	6.54	6.48	6.42	6.36	6.30	6.25	6.19	6.13	6.07	6.01	5.96	5.90	5.84	5.78	
80.0	5.98	6.13	6.29	6.45	7.02	6.97	6.91	6.85	6.79	6.73	6.68	6.62	6.56	6.50	6.44	6.39	6.33	6.27	6.21	6.15	6.10	6.04	5.98	5.92	5.86	
80.5	6.04	6.20	6.35	6.51	7.11	7.05	6.99	6.93	6.87	6.8.																

TABLE 2. PREDICTED FEV1 FOR MALES (Knudson, Et Al. AM REV RESPIR DIS. 1976, 113, 587.

HT	AGE		17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61	63	65
60.0	2.97	3.06	3.15	3.24	3.05	2.99	2.94	2.88	2.83	2.78	2.72	2.67	2.61	2.56	2.51	2.45	2.40	2.34	2.29	2.24	2.18	2.13	2.07	2.02	2.02	1.97	
60.5	3.03	3.12	3.21	3.30	3.11	3.06	3.00	2.95	2.90	2.84	2.79	2.73	2.68	2.63	2.57	2.52	2.46	2.41	2.36	2.30	2.25	2.19	2.14	2.09	2.03		
61.0	3.08	3.17	3.26	3.35	3.18	3.12	3.07	3.02	2.96	2.91	2.85	2.80	2.75	2.69	2.64	2.58	2.53	2.48	2.42	2.37	2.31	2.26	2.21	2.15	2.10		
61.5	3.14	3.23	3.32	3.41	3.24	3.19	3.14	3.08	3.03	2.97	2.92	2.87	2.81	2.76	2.70	2.65	2.60	2.54	2.49	2.43	2.38	2.33	2.27	2.22	2.16		
62.0	3.20	3.29	3.38	3.47	3.31	3.26	3.20	3.15	3.09	3.04	2.99	2.93	2.88	2.82	2.77	2.72	2.66	2.61	2.55	2.50	2.45	2.39	2.34	2.28	2.23		
62.5	3.26	3.35	3.44	3.53	3.38	3.32	3.27	3.22	3.16	3.11	3.05	3.00	2.95	2.89	2.84	2.78	2.73	2.68	2.62	2.57	2.51	2.46	2.41	2.35	2.30		
63.0	3.32	3.41	3.50	3.59	3.44	3.39	3.34	3.28	3.23	3.17	3.12	3.07	3.01	2.96	2.90	2.85	2.80	2.74	2.69	2.63	2.58	2.53	2.47	2.42	2.36		
63.5	3.38	3.47	3.56	3.65	3.51	3.46	3.40	3.35	3.29	3.24	3.19	3.13	3.08	3.02	2.97	2.92	2.86	2.81	2.75	2.70	2.65	2.59	2.54	2.48	2.43		
64.0	3.43	3.52	3.61	3.70	3.58	3.52	3.47	3.41	3.36	3.31	3.25	3.20	3.14	3.09	3.04	2.98	2.93	2.87	2.82	2.77	2.71	2.66	2.60	2.55	2.50		
64.5	3.49	3.58	3.67	3.76	3.64	3.59	3.53	3.48	3.43	3.37	3.32	3.26	3.21	3.16	3.10	3.05	2.99	2.94	2.89	2.83	2.78	2.72	2.67	2.62	2.56		
65.0	3.55	3.64	3.73	3.82	3.71	3.65	3.60	3.55	3.49	3.44	3.38	3.33	3.28	3.22	3.17	3.11	3.06	3.01	2.95	2.90	2.84	2.79	2.74	2.68	2.63		
65.5	3.61	3.70	3.79	3.88	3.77	3.72	3.67	3.61	3.56	3.50	3.45	3.40	3.34	3.29	3.23	3.18	3.13	3.07	3.02	2.96	2.91	2.86	2.80	2.75	2.69		
66.0	3.67	3.76	3.85	3.94	3.84	3.79	3.73	3.68	3.62	3.57	3.52	3.46	3.41	3.35	3.30	3.25	3.19	3.14	3.08	3.03	2.98	2.92	2.87	2.81	2.76		
66.5	3.73	3.82	3.91	4.00	3.91	3.85	3.80	3.74	3.69	3.64	3.58	3.53	3.47	3.42	3.37	3.31	3.26	3.20	3.15	3.10	3.04	2.99	2.93	2.88	2.83		
67.0	3.79	3.88	3.97	4.06	3.97	3.92	3.86	3.81	3.76	3.70	3.65	3.59	3.54	3.49	3.43	3.38	3.32	3.27	3.22	3.16	3.11	3.05	3.00	2.95	2.89		
67.5	3.84	3.93	4.02	4.11	4.04	3.98	3.93	3.88	3.82	3.77	3.71	3.66	3.61	3.55	3.50	3.44	3.39	3.34	3.28	3.23	3.17	3.12	3.07	3.01	2.96		
68.0	3.90	3.99	4.08	4.17	4.10	4.06	4.00	3.94	3.89	3.83	3.78	3.73	3.67	3.62	3.56	3.51	3.46	3.40	3.35	3.29	3.24	3.19	3.13	3.08	3.02		
68.5	3.96	4.05	4.14	4.23	4.17	4.12	4.06	4.01	3.95	3.90	3.85	3.79	3.74	3.68	3.63	3.58	3.52	3.47	3.41	3.36	3.31	3.25	3.20	3.14	3.09		
69.0	4.02	4.11	4.20	4.29	4.24	4.18	4.13	4.07	4.02	3.97	3.91	3.86	3.80	3.75	3.70	3.64	3.59	3.53	3.48	3.43	3.37	3.32	3.26	3.21	3.16		
69.5	4.08	4.17	4.26	4.35	4.30	4.25	4.19	4.14	4.09	4.03	3.98	3.92	3.87	3.82	3.76	3.71	3.65	3.60	3.55	3.49	3.44	3.38	3.33	3.28	3.22		
70.0	4.14	4.23	4.32	4.41	4.37	4.31	4.26	4.21	4.15	4.10	4.04	3.99	3.94	3.88	3.83	3.77	3.72	3.67	3.61	3.56	3.50	3.45	3.40	3.34	3.29		
70.5	4.19	4.28	4.37	4.46	4.43	4.38	4.33	4.27	4.22	4.16	4.11	4.06	4.00	3.95	3.89	3.84	3.79	3.73	3.68	3.62	3.57	3.52	3.46	3.41	3.35		
71.0	4.25	4.34	4.43	4.52	4.50	4.45	4.39	4.34	4.28	4.23	4.18	4.12	4.07	4.01	3.96	3.91	3.85	3.80	3.74	3.69	3.64	3.58	3.53	3.47	3.42		
71.5	4.31	4.40	4.49	4.58	4.57	4.51	4.46	4.40	4.35	4.30	4.24	4.19	4.13	4.08	4.03	3.97	3.92	3.86	3.81	3.76	3.70	3.65	3.59	3.54	3.49		
72.0	4.37	4.46	4.55	4.64	4.63	4.58	4.52	4.47	4.42	4.36	4.31	4.25	4.20	4.15	4.09	4.04	3.98	3.93	3.88	3.82	3.77	3.71	3.66	3.61	3.55		
72.5	4.43	4.52	4.61	4.70	4.70	4.64	4.59	4.54	4.48	4.43	4.37	4.32	4.27	4.21	4.16	4.10	4.05	4.00	3.94	3.89	3.83	3.78	3.73	3.67	3.62		
73.0	4.49	4.58	4.67	4.76	4.76	4.71	4.66	4.60	4.55	4.49	4.44	4.39	4.33	4.28	4.22	4.17	4.12	4.06	4.01	3.95	3.90	3.85	3.79	3.74	3.68		
73.5	4.54	4.63	4.72	4.81	4.83	4.78	4.72	4.67	4.61	4.56	4.51	4.45	4.40	4.34	4.29	4.24	4.18	4.13	4.07	4.02	3.97	3.91	3.86	3.80	3.75		
74.0	4.60	4.69	4.78	4.87	4.90	4.84	4.79	4.73	4.68	4.63	4.57	4.52	4.46	4.41	4.36	4.30	4.25	4.19	4.14	4.09	4.03	3.98	3.92	3.87	3.82		
74.5	4.66	4.75	4.84	4.93	4.96	4.91	4.85	4.80	4.75	4.69	4.64	4.58	4.53	4.48	4.42	4.37	4.31	4.26	4.21	4.15	4.10	4.04	3.99	3.94	3.88		
75.0	4.72	4.81	4.90	4.99	5.03	4.97	4.92	4.87	4.81	4.76	4.70	4.65	4.60	4.54	4.49	4.43	4.38	4.33	4.27	4.22	4.16	4.11	4.06	4.00	3.95		
75.5	4.78	4.87	4.96	5.05	5.09	5.04	4.99	4.93	4.88	4.82	4.77	4.72	4.66	4.61	4.55	4.50	4.45	4.39	4.34	4.28	4.23	4.18	4.12	4.07	4.01		
76.0	4.84	4.93	5.02	5.11	5.16	5.11	5.05	5.00	4.94	4.89	4.84	4.78	4.73	4.67	4.62	4.57	4.51	4.46	4.40	4.35	4.30	4.24	4.19	4.13	4.08		
76.5	4.90	4.99	5.08	5.17	5.23	5.17	5.12	5.06	5.01	4.96	4.90	4.85	4.79	4.74	4.69	4.63	4.58	4.52	4.47	4.42	4.36	4.31	4.25	4.20	4.15		
77.0	4.95	5.04	5.13	5.22	5.29	5.24	5.18	5.13	5.08	5.02	4.97	4.91	4.86	4.81	4.75	4.70	4.64	4.59	4.54	4.48	4.43	4.37	4.32	4.27	4.21		
77.5	5.01	5.10	5.19	5.28	5.36	5.30	5.25	5.20	5.14	5.09	5.03	4.98	4.93	4.87	4.82	4.76	4.71	4.66	4.60	4.55	4.49	4.44	4.39	4.33	4.28		
78.0	5.07	5.16	5.25	5.34	5.42	5.37	5.32	5.26	5.21	5.15	5.10	5.05	4.99	4.94	4.88	4.83	4.78	4.72	4.67	4.61	4.56	4.51	4.45	4.40	4.34		
78.5	5.13	5.22	5.31	5.40	5.49	5.44	5.38	5.33	5.27	5.22	5.17	5.11	5.06	5.00	4.95	4.90	4.84	4.79	4.73	4.68	4.63	4.57	4.52	4.46	4.41		
79.0	5.19	5.28	5.37	5.46	5.56	5.50	5.45	5.39	5.34	5.29	5.23	5.18	5.12	5.07	5.02	4.96	4.91	4.85	4.80	4.75	4.69	4.64	4.58	4.53	4.48		
79.5	5.25	5.34	5.43	5.52	5.62	5.57	5.51	5.46	5.41	5.35	5.30	5.24	5.19	5.14	5.08	5.03	4.97	4.92	4.87	4.81	4.76	4.70	4.65	4.60	4.54		
80.0	5.30	5.39	5.48	5.57	5.69	5.63	5.58	5.53	5.47	5.42	5.36	5.31	5.26	5.20	5.15	5.09	5.04	4.99	4.93	4.88	4.82	4.77	4.72	4.66	4.61		
80.5	5.36	5.45	5.54	5.63	5.75	5.70	5.65	5.59	5.54	5.48	5.43	5.38	5.32	5.27	5.21	5.16	5.11	5.05	5.00	4.94	4.89	4.84	4.78	4.73	4.67		
81.0	5.42	5.51	5.60	5.69	5.82	5.77	5.71	5.66	5.60	5.55	5.50	5.44	5.39	5.33	5.28	5.23	5.17	5.12	5.06	5.01	4.96	4.90	4.85	4.79	4.74		
81.5	5.48	5.57	5.66	5.75	5.89	5.83	5.78	5.72	5.67	5.62	5.56	5.51	5.45	5.40	5.35	5.29	5.24	5.18	5.13	5.08	5.02	4.97	4.91	4.86	4.81		
82.0	5.54	5.63	5.72	5.81	5.95	5.90	5.84	5.79	5.74	5.68	5.63	5.57	5.52	5.47	5.41	5.36	5.30	5.25	5.20	5.14	5.09	5.03	4.98	4.93	4.87		
82.5	5.60	5.69	5.78	5.87	6.02	5.96	5.91	5.86	5.80	5.75	5.69	5.64	5.59	5.53	5.48	5.42	5.37	5.32	5.26	5.21	5.15	5.10	5.05	4.99	4.94		
83.0	5.65	5.74	5.83	5.92	6.08	6.03	5.98	5.92	5.87	5.81	5.76	5.71	5.65	5.60	5.54	5.49	5.44	5.38	5.33	5.27	5.22	5.17	5.11	5.06	5.00		
83.5	5.71	5.80	5.90	5.98	6.15	6.10	6.04	5.99	5.93	5.88	5.83	5.77	5.72	5.66	5.61	5.56	5.50	5.45	5.39	5.34	5.29	5.23	5.18	5.12	5.07		
84.0	5.77	5.86	5.95	6.04	6.22	6.16	6.11	6.05	6.00	5.95	5.89	5.84	5.78	5.73	5.68	5.62	5.57	5.51	5.46	5.41	5.35	5.30	5.24	5.19	5.14		
84.5	5.83	5.92	6.01	6.10	6.28	6.23	6.17	6.12	6.07	6.01	5.96	5.90	5.85	5.80	5.74	5.69	5.63	5.58	5.53	5.47	5.42	5.36	5.31	5.26	5.20		
85.0	5.89	5.98	6.07	6.16	6.35	6.29	6.24	6																			

HT	AGE		TABLE 3. PREDICTED FVC FOR FEMALES (Knudson, Et Al. AM REV RESPIR DIS. 1976, 113, 587.																						
	17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61	63	65
52.0	2.45	2.64	2.65	2.61	2.56	2.52	2.47	2.43	2.39	2.34	2.30	2.25	2.21	2.17	2.12	2.08	2.03	1.99	1.95	1.90	1.86	1.81	1.77	1.73	1.68
52.5	2.50	2.68	2.70	2.65	2.61	2.57	2.52	2.48	2.43	2.39	2.35	2.30	2.26	2.21	2.17	2.13	2.08	2.04	1.99	1.95	1.91	1.86	1.82	1.77	1.73
53.0	2.54	2.72	2.74	2.70	2.66	2.61	2.57	2.52	2.48	2.44	2.39	2.35	2.30	2.26	2.22	2.17	2.13	2.08	2.04	2.00	1.95	1.91	1.86	1.82	1.78
53.5	2.58	2.76	2.79	2.75	2.70	2.66	2.62	2.57	2.53	2.48	2.44	2.40	2.35	2.31	2.26	2.22	2.18	2.13	2.09	2.04	2.00	1.96	1.91	1.87	1.82
54.0	2.62	2.81	2.84	2.79	2.75	2.71	2.66	2.62	2.57	2.53	2.49	2.44	2.40	2.35	2.31	2.27	2.22	2.18	2.13	2.09	2.05	2.00	1.96	1.91	1.87
54.5	2.66	2.85	2.89	2.84	2.80	2.75	2.71	2.67	2.62	2.58	2.53	2.49	2.45	2.40	2.36	2.31	2.27	2.23	2.18	2.14	2.09	2.05	2.01	1.96	1.92
55.0	2.71	2.89	2.93	2.89	2.84	2.80	2.76	2.71	2.67	2.62	2.58	2.54	2.49	2.45	2.40	2.36	2.32	2.27	2.23	2.18	2.14	2.10	2.05	2.01	1.96
55.5	2.75	2.93	2.98	2.94	2.89	2.85	2.80	2.76	2.72	2.67	2.63	2.58	2.54	2.50	2.45	2.41	2.36	2.32	2.28	2.23	2.19	2.14	2.10	2.06	2.01
56.0	2.79	2.97	3.03	2.98	2.94	2.89	2.85	2.81	2.76	2.72	2.67	2.63	2.59	2.54	2.50	2.45	2.41	2.37	2.32	2.28	2.23	2.19	2.15	2.10	2.06
56.5	2.83	3.01	3.07	3.03	2.99	2.94	2.90	2.85	2.81	2.77	2.72	2.68	2.63	2.59	2.55	2.50	2.46	2.41	2.37	2.33	2.28	2.24	2.19	2.15	2.11
57.0	2.87	3.06	3.12	3.08	3.03	2.99	2.94	2.90	2.86	2.81	2.77	2.72	2.68	2.64	2.59	2.55	2.50	2.46	2.42	2.37	2.33	2.28	2.24	2.20	2.15
57.5	2.91	3.10	3.17	3.12	3.08	3.04	2.99	2.95	2.90	2.86	2.82	2.77	2.73	2.68	2.64	2.60	2.55	2.51	2.46	2.42	2.38	2.33	2.29	2.24	2.20
58.0	2.96	3.14	3.21	3.17	3.13	3.08	3.04	2.99	2.95	2.91	2.86	2.82	2.77	2.73	2.69	2.64	2.60	2.55	2.51	2.47	2.42	2.38	2.33	2.29	2.25
58.5	3.00	3.18	3.26	3.22	3.17	3.13	3.09	3.04	3.00	2.95	2.91	2.87	2.82	2.78	2.73	2.69	2.65	2.60	2.56	2.51	2.47	2.43	2.38	2.34	2.29
59.0	3.04	3.22	3.31	3.26	3.22	3.18	3.13	3.09	3.04	3.00	2.96	2.91	2.87	2.82	2.78	2.74	2.69	2.65	2.60	2.56	2.52	2.47	2.43	2.38	2.34
59.5	3.08	3.27	3.36	3.31	3.27	3.22	3.18	3.14	3.09	3.05	3.00	2.96	2.92	2.87	2.83	2.78	2.74	2.70	2.65	2.61	2.56	2.52	2.48	2.43	2.39
60.0	3.12	3.31	3.40	3.36	3.31	3.27	3.23	3.18	3.14	3.09	3.05	3.01	2.96	2.92	2.87	2.83	2.79	2.74	2.70	2.65	2.61	2.57	2.52	2.48	2.43
60.5	3.17	3.35	3.45	3.41	3.36	3.32	3.27	3.23	3.19	3.14	3.10	3.05	3.01	2.97	2.92	2.88	2.83	2.79	2.75	2.70	2.66	2.61	2.57	2.53	2.48
61.0	3.21	3.39	3.50	3.45	3.41	3.36	3.32	3.28	3.23	3.19	3.14	3.10	3.06	3.01	2.97	2.92	2.88	2.84	2.79	2.75	2.70	2.66	2.62	2.57	2.53
61.5	3.25	3.43	3.54	3.50	3.46	3.41	3.37	3.32	3.28	3.24	3.19	3.15	3.10	3.06	3.02	2.97	2.93	2.88	2.84	2.80	2.75	2.71	2.66	2.62	2.58
62.0	3.29	3.48	3.59	3.55	3.50	3.46	3.41	3.37	3.33	3.28	3.24	3.19	3.15	3.11	3.06	3.02	2.97	2.93	2.89	2.84	2.80	2.75	2.71	2.67	2.62
62.5	3.33	3.52	3.64	3.59	3.55	3.51	3.46	3.42	3.37	3.33	3.29	3.24	3.20	3.15	3.11	3.07	3.02	2.98	2.93	2.89	2.85	2.80	2.76	2.71	2.67
63.0	3.38	3.56	3.68	3.64	3.60	3.55	3.51	3.46	3.42	3.38	3.33	3.29	3.24	3.20	3.16	3.11	3.07	3.02	2.98	2.94	2.89	2.85	2.80	2.76	2.72
63.5	3.42	3.60	3.73	3.69	3.64	3.60	3.56	3.51	3.47	3.42	3.38	3.34	3.29	3.25	3.20	3.16	3.12	3.07	3.03	2.98	2.94	2.90	2.85	2.81	2.76
64.0	3.46	3.64	3.78	3.73	3.69	3.65	3.60	3.56	3.51	3.47	3.43	3.38	3.34	3.29	3.25	3.21	3.16	3.12	3.07	3.03	2.99	2.94	2.90	2.85	2.81
64.5	3.50	3.69	3.83	3.78	3.74	3.69	3.65	3.61	3.56	3.52	3.47	3.43	3.39	3.34	3.30	3.25	3.21	3.17	3.12	3.08	3.03	2.99	2.95	2.90	2.86
65.0	3.54	3.73	3.87	3.83	3.78	3.74	3.70	3.65	3.61	3.56	3.52	3.48	3.43	3.39	3.34	3.30	3.26	3.21	3.17	3.12	3.08	3.04	2.99	2.95	2.90
65.5	3.59	3.77	3.92	3.88	3.83	3.79	3.74	3.70	3.66	3.61	3.57	3.52	3.48	3.44	3.39	3.35	3.30	3.26	3.22	3.17	3.13	3.08	3.04	3.00	2.95
66.0	3.63	3.81	3.97	3.92	3.88	3.83	3.79	3.75	3.70	3.66	3.61	3.57	3.53	3.48	3.44	3.39	3.35	3.31	3.26	3.22	3.17	3.13	3.09	3.04	3.00
66.5	3.67	3.85	4.01	3.97	3.93	3.88	3.84	3.79	3.75	3.71	3.66	3.62	3.57	3.53	3.49	3.44	3.40	3.35	3.31	3.27	3.22	3.18	3.13	3.09	3.05
67.0	3.71	3.89	4.06	4.02	3.97	3.93	3.88	3.84	3.80	3.75	3.71	3.66	3.62	3.58	3.53	3.49	3.44	3.40	3.36	3.31	3.27	3.22	3.18	3.14	3.09
67.5	3.75	3.94	4.11	4.06	4.02	3.98	3.93	3.89	3.84	3.80	3.76	3.71	3.67	3.62	3.58	3.54	3.49	3.45	3.40	3.36	3.32	3.27	3.23	3.18	3.14
68.0	3.79	3.98	4.15	4.11	4.07	4.02	3.98	3.93	3.89	3.85	3.80	3.76	3.71	3.67	3.63	3.58	3.54	3.49	3.45	3.41	3.36	3.32	3.27	3.23	3.19
68.5	3.84	4.02	4.20	4.16	4.11	4.07	4.03	3.98	3.94	3.89	3.85	3.81	3.76	3.72	3.67	3.63	3.59	3.54	3.50	3.45	3.41	3.37	3.32	3.28	3.23
69.0	3.88	4.06	4.25	4.20	4.16	4.12	4.07	4.03	3.98	3.94	3.90	3.85	3.81	3.76	3.72	3.68	3.63	3.59	3.54	3.50	3.46	3.41	3.37	3.32	3.28
69.5	3.92	4.10	4.30	4.25	4.21	4.16	4.12	4.08	4.03	3.99	3.94	3.90	3.86	3.81	3.77	3.72	3.68	3.64	3.59	3.55	3.50	3.46	3.42	3.37	3.33
70.0	3.96	4.15	4.34	4.30	4.25	4.21	4.17	4.12	4.08	4.03	3.99	3.95	3.90	3.86	3.81	3.77	3.73	3.68	3.64	3.59	3.55	3.51	3.46	3.42	3.37
70.5	4.00	4.19	4.39	4.35	4.30	4.26	4.21	4.17	4.13	4.08	4.04	3.99	3.95	3.91	3.86	3.82	3.77	3.73	3.69	3.64	3.60	3.55	3.51	3.47	3.42
71.0	4.05	4.23	4.44	4.39	4.35	4.30	4.26	4.22	4.17	4.13	4.08	4.04	4.00	3.95	3.91	3.86	3.82	3.78	3.73	3.69	3.64	3.60	3.56	3.51	3.47
71.5	4.09	4.27	4.48	4.44	4.40	4.35	4.31	4.26	4.22	4.18	4.13	4.09	4.04	4.00	3.96	3.91	3.87	3.82	3.78	3.74	3.69	3.65	3.60	3.56	3.52
72.0	4.13	4.31	4.53	4.49	4.44	4.40	4.35	4.31	4.27	4.22	4.18	4.13	4.09	4.05	4.00	3.96	3.91	3.87	3.83	3.78	3.74	3.69	3.65	3.61	3.56
72.5	4.17	4.36	4.58	4.53	4.49	4.45	4.40	4.36	4.31	4.27	4.23	4.18	4.14	4.09	4.05	4.01	3.96	3.92	3.87	3.83	3.79	3.74	3.70	3.65	3.61
73.0	4.21	4.40	4.62	4.58	4.54	4.49	4.45	4.40	4.36	4.32	4.27	4.23	4.18	4.14	4.10	4.05	4.01	3.96	3.92	3.88	3.83	3.79	3.74	3.70	3.66
73.5	4.26	4.44	4.67	4.63	4.58	4.54	4.50	4.45	4.41	4.36	4.32	4.28	4.23	4.19	4.14	4.10	4.06	4.01	3.97	3.92	3.88	3.84	3.79	3.75	3.70
74.0	4.30	4.48	4.72	4.67	4.63	4.59	4.54	4.50	4.45	4.41	4.37	4.32	4.28	4.23	4.19	4.15	4.10	4.06	4.01	3.97	3.93	3.88	3.84	3.79	3.75
74.5	4.34	4.52	4.77	4.72	4.68	4.63	4.59	4.55	4.50	4.46	4.41	4.37	4.33	4.28	4.24	4.19	4.15	4.11	4.06	4.02	3.97	3.93	3.89	3.84	3.80
75.0	4.38	4.57	4.81	4.77	4.72	4.68	4.64	4.59	4.55	4.50	4.46	4.42	4.37	4.33	4.28	4.24	4.20	4.15	4.11	4.06	4.02	3.98	3.93	3.89	3.84
75.5	4.42	4.61	4.86	4.82	4.77	4.73	4.68	4.64	4.60	4.55	4.51	4.46	4.42	4.38	4.33	4.29	4.24	4.20	4.16	4.11	4.07	4.02	3.98	3.94	3.89
76.0	4.47	4.65	4.91	4.86	4.82	4.77	4.73	4.69	4.64	4.60	4.55	4.51	4.47	4.42	4.38	4.33	4.29	4.25	4.20	4.16	4.11	4.07	4.03	3.98	3.94
76.5	4.51	4.69	4.95	4.91	4.87	4.82	4.78	4.73	4.69	4.65	4.60	4.56	4.51	4.47	4.43										

TABLE 4. PREDICTED FEV1 FOR FEMALES (Knudson, Et Al. AM REV RESPIR DIS. 1976, 113, 587.

HT	AGE		17	19	21	23	25	27	29	31	33	35	37	39	41	43	45	47	49	51	53	55	57	59	61	63	65
52.0	2.31	2.48	2.33	2.29	2.25	2.21	2.16	2.12	2.08	2.04	2.00	1.95	1.91	1.87	1.83	1.79	1.74	1.70	1.66	1.62	1.58	1.53	1.49	1.45	1.41	1.41	
52.5	2.34	2.51	2.37	2.32	2.28	2.24	2.20	2.16	2.11	2.07	2.03	1.99	1.95	1.90	1.86	1.82	1.78	1.74	1.69	1.65	1.61	1.57	1.53	1.48	1.44	1.44	
53.0	2.38	2.55	2.40	2.36	2.32	2.27	2.23	2.19	2.15	2.11	2.06	2.02	1.98	1.94	1.90	1.85	1.81	1.77	1.73	1.69	1.64	1.60	1.56	1.52	1.48	1.48	
53.5	2.41	2.58	2.43	2.39	2.35	2.31	2.27	2.22	2.18	2.14	2.10	2.06	2.01	1.97	1.93	1.89	1.85	1.80	1.76	1.72	1.68	1.64	1.59	1.55	1.51	1.51	
54.0	2.45	2.62	2.47	2.43	2.38	2.34	2.30	2.26	2.22	2.17	2.13	2.09	2.05	2.01	1.96	1.92	1.88	1.84	1.80	1.75	1.71	1.67	1.63	1.59	1.54	1.54	
54.5	2.48	2.65	2.50	2.46	2.42	2.38	2.33	2.29	2.25	2.21	2.17	2.12	2.08	2.04	2.00	1.96	1.91	1.87	1.83	1.79	1.75	1.70	1.66	1.62	1.58	1.58	
55.0	2.51	2.68	2.54	2.49	2.45	2.41	2.37	2.33	2.28	2.24	2.20	2.16	2.12	2.07	2.03	1.99	1.95	1.91	1.86	1.82	1.78	1.74	1.70	1.65	1.61	1.61	
55.5	2.55	2.72	2.57	2.53	2.49	2.45	2.40	2.36	2.32	2.28	2.24	2.19	2.15	2.11	2.07	2.03	1.98	1.94	1.90	1.86	1.82	1.77	1.73	1.69	1.65	1.65	
56.0	2.58	2.75	2.61	2.56	2.52	2.48	2.44	2.40	2.35	2.31	2.27	2.23	2.19	2.14	2.10	2.06	2.02	1.98	1.93	1.89	1.85	1.81	1.77	1.72	1.68	1.68	
56.5	2.62	2.79	2.64	2.60	2.56	2.51	2.47	2.43	2.39	2.35	2.30	2.26	2.22	2.18	2.14	2.09	2.05	2.01	1.97	1.93	1.88	1.84	1.80	1.76	1.72	1.72	
57.0	2.65	2.82	2.67	2.63	2.59	2.55	2.51	2.46	2.42	2.38	2.34	2.30	2.25	2.21	2.17	2.13	2.09	2.04	2.00	1.96	1.92	1.88	1.83	1.79	1.75	1.75	
57.5	2.69	2.86	2.71	2.67	2.62	2.58	2.54	2.50	2.46	2.41	2.37	2.33	2.29	2.25	2.20	2.16	2.12	2.08	2.04	1.99	1.95	1.91	1.87	1.83	1.78	1.78	
58.0	2.72	2.89	2.74	2.70	2.66	2.62	2.57	2.53	2.49	2.45	2.41	2.36	2.32	2.28	2.24	2.20	2.15	2.11	2.07	2.03	1.99	1.94	1.90	1.86	1.82	1.82	
58.5	2.75	2.92	2.78	2.73	2.69	2.65	2.61	2.57	2.52	2.48	2.44	2.40	2.36	2.31	2.27	2.23	2.19	2.15	2.10	2.06	2.02	1.98	1.94	1.89	1.85	1.85	
59.0	2.79	2.96	2.81	2.77	2.73	2.69	2.64	2.60	2.56	2.52	2.48	2.43	2.39	2.35	2.31	2.27	2.22	2.18	2.14	2.10	2.06	2.01	1.97	1.93	1.89	1.89	
59.5	2.82	2.99	2.85	2.80	2.76	2.72	2.68	2.64	2.59	2.55	2.51	2.47	2.43	2.38	2.34	2.30	2.26	2.22	2.17	2.13	2.09	2.05	2.01	1.96	1.92	1.92	
60.0	2.86	3.03	2.88	2.84	2.80	2.75	2.71	2.67	2.63	2.59	2.54	2.50	2.46	2.42	2.38	2.33	2.29	2.25	2.21	2.17	2.12	2.08	2.04	2.00	1.96	1.96	
60.5	2.89	3.06	2.91	2.87	2.83	2.79	2.75	2.70	2.66	2.62	2.58	2.54	2.49	2.45	2.41	2.37	2.33	2.28	2.24	2.20	2.16	2.12	2.07	2.03	1.99	1.99	
61.0	2.93	3.10	2.95	2.91	2.86	2.82	2.78	2.74	2.70	2.65	2.61	2.57	2.53	2.49	2.44	2.40	2.36	2.32	2.28	2.23	2.19	2.15	2.11	2.07	2.02	2.02	
61.5	2.96	3.13	2.98	2.94	2.90	2.86	2.81	2.77	2.73	2.69	2.65	2.60	2.56	2.52	2.48	2.44	2.39	2.35	2.31	2.27	2.23	2.18	2.14	2.10	2.06	2.06	
62.0	2.99	3.16	3.02	2.97	2.93	2.89	2.85	2.81	2.76	2.72	2.68	2.64	2.60	2.55	2.51	2.47	2.43	2.39	2.34	2.30	2.26	2.22	2.18	2.13	2.09	2.09	
62.5	3.03	3.20	3.05	3.01	2.97	2.93	2.88	2.84	2.80	2.76	2.72	2.67	2.63	2.59	2.55	2.51	2.46	2.42	2.38	2.34	2.30	2.25	2.21	2.17	2.13	2.13	
63.0	3.06	3.23	3.09	3.04	3.00	2.96	2.92	2.88	2.83	2.79	2.75	2.71	2.67	2.62	2.58	2.54	2.50	2.46	2.41	2.37	2.33	2.29	2.25	2.20	2.16	2.16	
63.5	3.10	3.27	3.12	3.08	3.04	2.99	2.95	2.91	2.87	2.83	2.78	2.74	2.70	2.66	2.62	2.57	2.53	2.49	2.45	2.41	2.36	2.32	2.28	2.24	2.20	2.20	
64.0	3.13	3.30	3.15	3.11	3.07	3.03	2.99	2.94	2.90	2.86	2.82	2.78	2.73	2.69	2.65	2.61	2.57	2.52	2.48	2.44	2.40	2.36	2.32	2.28	2.24	2.23	
64.5	3.17	3.34	3.19	3.15	3.10	3.06	3.02	2.98	2.94	2.89	2.85	2.81	2.77	2.73	2.68	2.64	2.60	2.56	2.52	2.47	2.43	2.39	2.35	2.31	2.26	2.26	
65.0	3.20	3.37	3.22	3.18	3.14	3.10	3.05	3.01	2.97	2.93	2.89	2.84	2.80	2.76	2.72	2.68	2.63	2.59	2.55	2.51	2.47	2.42	2.38	2.34	2.30	2.30	
65.5	3.23	3.40	3.26	3.21	3.17	3.13	3.09	3.05	3.00	2.96	2.92	2.88	2.84	2.79	2.75	2.71	2.67	2.63	2.58	2.54	2.50	2.46	2.42	2.37	2.33	2.33	
66.0	3.27	3.44	3.29	3.25	3.21	3.17	3.12	3.08	3.04	3.00	2.96	2.91	2.87	2.83	2.79	2.75	2.70	2.66	2.62	2.58	2.54	2.49	2.45	2.41	2.37	2.37	
66.5	3.30	3.47	3.33	3.28	3.24	3.20	3.16	3.12	3.07	3.03	2.99	2.95	2.91	2.86	2.82	2.78	2.74	2.70	2.65	2.61	2.57	2.53	2.49	2.44	2.40	2.40	
67.0	3.34	3.51	3.36	3.32	3.28	3.23	3.19	3.15	3.11	3.07	3.02	2.98	2.94	2.90	2.86	2.81	2.77	2.73	2.69	2.65	2.60	2.56	2.52	2.48	2.44	2.44	
67.5	3.37	3.54	3.39	3.35	3.31	3.27	3.23	3.18	3.14	3.10	3.06	3.02	2.97	2.94	2.89	2.85	2.81	2.76	2.72	2.68	2.64	2.60	2.55	2.51	2.47	2.47	
68.0	3.41	3.58	3.43	3.39	3.34	3.30	3.26	3.22	3.18	3.13	3.09	3.05	3.01	2.97	2.92	2.88	2.84	2.80	2.76	2.71	2.67	2.63	2.59	2.55	2.50	2.50	
68.5	3.44	3.61	3.46	3.42	3.38	3.34	3.29	3.25	3.21	3.17	3.13	3.08	3.04	3.00	2.96	2.92	2.87	2.83	2.79	2.75	2.71	2.66	2.62	2.58	2.54	2.54	
69.0	3.47	3.64	3.50	3.46	3.41	3.37	3.33	3.29	3.25	3.20	3.16	3.12	3.08	3.04	2.99	2.95	2.91	2.87	2.83	2.78	2.74	2.70	2.66	2.62	2.57	2.57	
69.5	3.51	3.68	3.53	3.49	3.45	3.41	3.36	3.32	3.28	3.24	3.20	3.15	3.11	3.07	3.03	2.99	2.94	2.90	2.86	2.82	2.78	2.73	2.69	2.65	2.61	2.61	
70.0	3.54	3.71	3.57	3.52	3.48	3.44	3.40	3.36	3.31	3.27	3.23	3.19	3.15	3.10	3.06	3.02	2.98	2.94	2.89	2.85	2.81	2.77	2.73	2.68	2.64	2.64	
70.5	3.58	3.75	3.60	3.56	3.52	3.47	3.43	3.39	3.35	3.31	3.26	3.22	3.18	3.14	3.10	3.05	3.01	2.97	2.93	2.89	2.84	2.80	2.76	2.72	2.68	2.68	
71.0	3.61	3.78	3.63	3.59	3.55	3.51	3.47	3.42	3.38	3.34	3.30	3.26	3.21	3.17	3.13	3.09	3.05	3.00	2.96	2.92	2.88	2.84	2.79	2.75	2.71	2.71	
71.5	3.65	3.82	3.67	3.63	3.58	3.54	3.50	3.46	3.42	3.37	3.33	3.29	3.25	3.21	3.16	3.12	3.08	3.04	3.00	2.95	2.91	2.87	2.83	2.79	2.74	2.74	
72.0	3.68	3.85	3.70	3.66	3.62	3.58	3.53	3.49	3.45	3.41	3.37	3.32	3.28	3.24	3.20	3.16	3.11	3.07	3.03	2.99	2.95	2.90	2.86	2.82	2.78	2.78	
72.5	3.71	3.88	3.74	3.70	3.65	3.61	3.57	3.53	3.49	3.44	3.40	3.36	3.32	3.28	3.23	3.19	3.15	3.11	3.07	3.02	2.98	2.94	2.90	2.86	2.81	2.81	
73.0	3.75	3.92	3.77	3.73	3.69	3.65	3.60	3.56	3.52	3.48	3.44	3.39	3.35	3.31	3.27	3.23	3.18	3.14	3.10	3.06	3.02	2.97	2.93	2.89	2.85	2.85	
73.5	3.78	3.95	3.81	3.76	3.72	3.68	3.64	3.60	3.55	3.51	3.47	3.43	3.39	3.34	3.30	3.26	3.22	3.18	3.13	3.09	3.05	3.01	2.97	2.92	2.88	2.88	
74.0	3.82	3.99	3.84	3.80	3.76	3.71	3.67	3.63	3.59	3.55	3.50	3.46	3.42	3.38	3.34	3.29	3.25	3.21	3.17	3.13	3.08	3.04	3.00	2.96	2.92	2.92	
74.5	3.85	4.02	3.87	3.83	3.79	3.75	3.71	3.66	3.62	3.58	3.54	3.50	3.45	3.41	3.37	3.33	3.29	3.24	3.20	3.16	3.12	3.08	3.03	2.99	2.95	2.95	
75.0	3.89	4.06	3.91	3.87	3.82	3.78	3.74	3.70	3.66	3.61	3.57	3.53	3.49	3.45	3.40	3.36	3.32	3.28	3.24	3.19	3.15	3.11	3.07	3.03	2.98	2.98	
75.5	3.92	4.09	3.94	3.90	3.86	3.82	3.77	3.73	3.69	3.65	3.61	3.56	3.52	3.48	3.44	3.40	3.35	3.31	3.27	3.23	3.19	3.14	3.10	3.06	3.02	3.02	
76.0	3.95	4.12	3.98	3.94	3.89	3.85	3.81	3.77	3.73	3.68	3.64	3.60	3.56	3.													

APPENDIX D to §1910.1043
PULMONARY FUNCTION STANDARDS FOR COTTON DUST STANDARD

The spirometric measurements of pulmonary function shall conform to the following minimum standards, and these standards are not intended to preclude additional testing or alternate methods which can be determined to be superior.

I. APPARATUS

- a. The instrument shall be accurate to within ± 50 milliliters or within ± 3 percent of reading, whichever is greater.
- b. The instrument should be capable of measuring vital capacity from 0 to 7 liters BTPS.
- c. The instrument shall have a low inertia and offer low resistance to airflow such that the resistance to airflow at 12 liters per second must be less than 1.5 cm H₂(liter/sec).
- d. The zero time point for the purpose of timing the FEV₁ shall be determined by extrapolating the steepest portion of the volume time curve back to the maximal inspiration volume (1, 2, 3, 4) or by an equivalent method.
- e. Instruments incorporating measurements of airflow to determine volume shall conform to the same volume accuracy stated in (a) of this section when presented with flow rates from at least 0 to 12 liters per second.
- f. The instrument or user of the instrument must have a means of correcting volumes to body temperature saturated with water vapor (BTPS) under conditions of varying ambient spirometer temperatures and barometric pressures.
- g. The instrument used shall provide a tracing or display of either flow versus volume or volume versus time during the entire forced expiration. A tracing or display is necessary to determine whether the patient has performed the test properly. The tracing must be stored and available for recall and must be of sufficient size that hand measurements may be made within the requirement of paragraph (a) of this section. If a paper record is made it must have a paper speed of at least 2 cm/sec and a volume sensitivity of at least 10.0 mm of chart per liter of volume.
- h. The instrument shall be capable of accumulating volume for a minimum of 10 seconds and shall not stop accumulating volume before (1) the volume change for a 0.5 second interval is less than 25 milliliters, or (2) the flow is less than 50 milliliters per second for a 0.5 second interval.
- i. The forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV_{1.0}) measurements shall comply with the accuracy requirements stated in paragraph (a) of this section. That is, they should be accurately measured to within ± 50 ml or within ± 3 percent of reading.
- j. The instrument must be capable of being calibrated in the field with respect to the FEV₁ and FVC may be either directly or indirectly through volume and time base measurements. The volume and time base measurements. The volume calibration source should provide a volume displacement of at least 2 liters and should be accurate to within ± 30 milliliters.

II. TECHNIQUE FOR MEASUREMENT OF FORCED VITAL CAPACITY MANEUVER

- a. Use of noise clip is recommended but not required. The procedures shall be explained in simple terms to the patient who shall be instructed to loosen any tight clothing and stand in front of the apparatus. The subject may sit, but care should be taken on repeat testing that the same position be used and, if possible, the same spirometer. Particular attention shall be given to insure that the chin is slightly elevated with the neck slightly extended. The patient shall be instructed to make a full inspiration from a normal breathing pattern and then blow into the apparatus, without interruption, as hard, fast, and completely as possible. At least three forced expirations shall be carried out. During the maneuvers, the patient shall be observed for compliance with instruction. The expirations shall be checked visually for reproducibility from flow-volume or volume-time tracings or displays. The following efforts shall be judged unacceptable when the patient:
 1. Has not reached full inspiration preceding the forced expiration.
 2. Has not used maximal effort during the entire forced expiration.
 3. Has not continued the expiration for at least 5 seconds or until an obvious plateau in the volume time curve has occurred.
 4. Has coughed or closed his glottis.
 5. Has an obstructed mouthpiece or a leak around the mouthpiece (obstruction due to tongue

- being placed in front of mouthpiece, false teeth falling in front of mouthpiece, etc.)
6. Has an unsatisfactory start of expiration, one characterized by excessive hesitation (or false starts), and therefore not allowing back extrapolation of time 0 (extrapolated volume on the volume time tracing must be less than 10 percent of the FVC.)
 7. Has an excessive variability between the three acceptable curves. The variation between the two largest FVC's and FEV₁'s of the three satisfactory tracings should not exceed 10 percent or ± 100 milliliters, whichever is greater.
- b. Periodic and routine recalibration of the instrument or method for recording FVC and FEV_{1.0} should be performed using a syringe or other volume source of at least 2 liters.

III. INTERPRETATION OF SPIROGRAM

- a. The first step in evaluating a spirogram should be to determine whether or not the patient has performed the test properly or as described in II above. From the three satisfactory tracings, the forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV_{1.0}) shall be measured and recorded. The largest observed FVC and largest observed FEV₁ shall be used in the analysis regardless of the curve(s) on which they occur.
- b. The following guidelines are recommended by NIOSH for the evaluation and management of workers exposed to cotton dust. It is important to note that employees who show reductions in FEV₁/FVC ratio below .75 or drops in Monday FEV₁ of 5 percent or greater on their initial screening exam, should be re-evaluated within a month of the first exam. Those who show consistent decrease in lung function, as shown on the following table, should be managed as recommended.

IV. QUALIFICATIONS OF PERSONNEL ADMINISTERING THE TEST

Technicians who perform pulmonary function testing should have the basic knowledge required to produce meaningful results. Training consisting of approximately 16 hours of formal instruction should cover the following areas.

- a. Basic physiology of the forced vital capacity maneuver and the determinants of airflow limitation with emphasis on the relation of reproducibility of results.
- b. Instruction requirements including calibration procedures, sources of error and their correction.
- c. Performance of the testing including subject coaching, recognition of improperly performed maneuvers and corrective actions.
- d. Data quality with emphasis on reproducibility.
- e. Actual use of the equipment under supervised conditions.
- f. Measurement of tracings and calculations of results.

APPENDIX E to §1910.1043 VERTICAL ELUTRIATOR EQUIVALENCY PROTOCOL

- a. Samples to be taken - In order to ascertain equivalency, it is necessary to collect a total of 100 samples from at least 10 sites in a mill. That is, there should be 10 replicate readings at each of 10 sites. The sites should represent dust levels which vary over the allowable range of 0.5 to 2 times the permissible exposure limit. Each sample requires the use of two vertical elutriators (VE's) and at least one but not more than two alternative devices (AD's). Thus, the end result is 200 VE readings and either 100 or 200 AD readings. The 2 VE readings and the 1 or 2 AD readings at each time and site must be made simultaneously. That is, the two VE's and one or two AD's must be arranged together in such a way that they are measuring essentially the same dust levels.
- b. Data averaging - The two VE readings taken at each site are then averaged. These averages are to be used as the 100 VE readings. If two alternate devices were used, their test results are also averaged. Thus, after this step is accomplished, there will be 100 VE readings and 100 AD readings.
- c. Differences - For each of the 100 sets of measurements (VE and AD) the difference is obtained as the average VE reading minus the AD reading. Call these differences D_i . Thus, we have.

$$D_i = VE_i - AD_i = 1, 2, \dots, 100 \quad (1) \dots$$

Next we compute the arithmetic mean and standard deviations of the differences, using equations (2) and (3), respectively.

$$\bar{X}_D = \frac{1}{N} \sum_{i=1}^N D_i \quad (2)$$

$$SD = \sqrt{\frac{\sum D_i^2 - \frac{(\sum D_i)^2}{N}}{N-1}} \quad (3)$$

where N equals the number of differences (100 in this case), \bar{X}_D is the arithmetic mean and SD is the standard deviation.

We next calculate the critical value as $T = KSD + [\bar{X}_D]$ where $K = 1.87$, based on 100 samples.

- d. Equivalency test. The next step is to obtain the average of the 100 VE readings. This is obtained by equation (4)

$$\bar{X}_{VE} = \frac{1}{N} \left(\sum_{i=1}^N VE_i \right)$$

We next multiply 0.25 by \bar{X}_{VE} If $T \leq 0.25 \bar{X}_{VE}$. We can say that the alternate device has passed the equivalency test.

(b) Definitions. As used in 29 CFR section 1910.1043 and applied to this section:

"§1910.20" means section 1910.20 in section 12-202-3. [Eff 7/6/98; am 12/29/01; 3/31/06] (Auth: HRS §396-4) (Imp: HRS §396-4)

Historical note: §12-202-32.1 is based substantially upon section 12-202-32. [Eff 7/12/82, am 8/5/88; R 7/6/98]

§12-202-33.1 Lead. (a) Incorporation of federal standard. Title 29. Code of Federal Regulations, section 1910.1025, entitled "Lead", published by the Office of the Federal Register. National Archives and published on November 14, 1978; and the amendments published on October 23, 1979; November 30, 1979; November 12, 1982; March 8, 1983; April 30, 1984; May 31, 1991; October 11, 1995; January 8, 1998; April 23, 1998; and January 5, 2005, are made a part of this section, except as provided in subsection (b).

§1910.1025 Lead.

(a) Scope and application.

- (1) This section applies to all occupational exposure to lead, except as provided in paragraph (a)(2).
- (2) This section does not apply to the construction industry or to agricultural operations covered by 29 CFR Part 1928.

(b) Definitions.

Action level means employee exposure, without regard to the use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air ($30 \mu\text{g}/\text{m}^3$) averaged over an 8-hour period.

Assistant Secretary means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

Director means the Director, National Institute for Occupational Safety and Health (NIOSH), U.S. Department of Health, Education, and Welfare, or designee.

Lead means metallic lead, all inorganic lead compounds, and organic lead soaps. Excluded from this definition are all other organic lead compounds.

(c) Permissible exposure limit (PEL).

- (1) The employer shall assure that no employee is exposed to lead at concentrations greater than fifty micrograms per cubic meter of air ($50 \mu\text{g}/\text{m}^3$) averaged over an 8-hour period.
- (2) If an employee is exposed to lead for more than 8 hours in any workday, the permissible exposure limit, as a time weighted average (TWA) for that day, shall be reduced according to the following formula:

$$\text{Maximum permissible limit (in } \mu\text{g}/\text{m}^3) = 400 \div \text{hours worked in the day.}$$

- (3) When respirators are used to supplement engineering and work practice controls to comply with the PEL and all the requirements of paragraph (f) have been met, employee exposure, for the purpose of determining whether the employer has complied with the PEL, may be considered to be at the level provided by the protection factor of the respirator for those periods the respirator is worn. Those periods may be averaged with exposure levels during periods when respirators are not worn to determine the employee's daily TWA exposure.

(d) Exposure monitoring

- (1) General.
 - (i) For the purposes of paragraph (d), employee exposure is that exposure that would occur if the employee were not using a respirator.
 - (ii) With the exception of monitoring under paragraph (d)(3), the employer shall collect full shift (for at least 7 continuous hours) personal samples including at least one sample for each shift for each job classification in each work area.
 - (iii) Full shift personal samples shall be representative of the monitored employee's regular, daily exposure to lead.
- (2) Initial determination. Each employer who has a workplace or work operation covered by this standard shall determine if any employee may be exposed to lead at or above the action level.
- (3) Basis of initial determination.
 - (i) The employer shall monitor employee exposures and shall base initial determinations on the employee exposure monitoring results and any of the following, relevant considerations:
 - (A) Any information, observations, or calculations that would indicate employee exposure to lead;
 - (B) Any previous measurements of airborne lead; and
 - (C) Any employee complaints of symptoms that may be attributable to exposure to lead.
 - (ii) Monitoring for the initial determination may be limited to a representative sample of the exposed employees who the employer reasonably believes are exposed to the greatest airborne concentrations of lead in the workplace.
 - (iii) Measurements of airborne lead made in the preceding 12 months may be used to satisfy the requirement to monitor under paragraph (d)(3)(i) if the sampling and analytical methods used meet the accuracy and confidence levels of paragraph (d)(9) of this section.
- (4) Positive initial determination and initial monitoring.
 - (i) Where a determination conducted under paragraphs (d)(2) and (3) of this section shows the possibility of any employee exposure at or above the action level, the employer shall conduct monitoring that is representative of the exposure for each employee in the workplace who is exposed to lead.
 - (ii) Measurements of airborne lead made in the preceding 12 months may be used to satisfy this requirement if the sampling and analytical methods used meet the accuracy and confidence levels of paragraph (d)(9) of this section.
- (5) Negative initial determination. Where a determination, conducted under paragraphs (d)(2) and (3) of this section is made that no employee is exposed to airborne concentrations of lead at or above the action level, the employer shall make a written record of such determination. The

record shall include at least the information specified in paragraph (d)(3) of this section and shall also include the date of determination, location within the worksite, and the name and social security number of each employee monitored.

- (6) Frequency.
 - (i) If the initial monitoring reveals employee exposure to be below the action level the measurements need not be repeated except as otherwise provided in paragraph (d)(7) of this section.
 - (ii) If the initial determination or subsequent monitoring reveals employee exposure to be at or above the action level but below the permissible exposure limit the employer shall repeat monitoring in accordance with this paragraph at least every 6 months. The employer shall continue monitoring at the required frequency until at least two consecutive measurements, taken at least 7 days apart, are below the action level at that time the employer may discontinue monitoring for that employee except as otherwise provided in paragraph (d)(7) of this section.
 - (iii) If the initial monitoring reveals that employee exposure is above the permissible exposure limit the employer shall repeat monitoring quarterly. The employer shall continue monitoring at the required frequency until at least two consecutive measurements, taken at least 7 days apart, are below the PEL but at or above the action level at that time the employer shall repeat monitoring for that employee at the frequency specified in paragraph (d)(6)(ii), except as otherwise provided in paragraph (d)(7) of this section.
- (7) Additional monitoring. Whenever there has been a production, process, control or personnel change that may result in new or additional exposure to lead, or whenever the employer has any other reason to suspect a change that may result in new or additional exposures to lead, additional monitoring in accordance with this paragraph shall be conducted.
- (8) Employee notification.
 - (i) The employer must, within 15 working days after the receipt of the results of any monitoring performed under this section, notify each affected employee of these results either individually in writing or by posting the results in an appropriate location that is accessible to affected employees.
 - (ii) Whenever the results indicate that the representative employee exposure, without regard to respirators, exceeds the permissible exposure limit, the employer shall include in the written notice a statement that the permissible exposure limit was exceeded and a description of the corrective action taken or to be taken to reduce exposure to or below the permissible exposure limit.
- (9) Accuracy of measurement. The employer shall use a method of monitoring and analysis that has an accuracy (to a confidence level of 95%) of not less than plus or minus 20 percent for airborne concentrations of lead equal to or greater than $30 \mu\text{g}/\text{m}^3$.
- (e) Methods of compliance
 - (1) Engineering and work practice controls.
 - (i) Where any employee is exposed to lead above the permissible exposure limit for more than 30 days per year, the employer shall implement engineering and work practice controls (including administrative controls) to reduce and maintain employee exposure to lead in accordance with the implementation schedule in Table I below, except to the extent that the employer can demonstrate that such controls are not feasible. Wherever the engineering and work practice controls that can be instituted are not sufficient to reduce employee exposure to or below the permissible exposure limit, the employer shall nonetheless use them to reduce exposures to the lowest feasible level and shall supplement them by the use of respiratory protection that complies with the requirements of paragraph (f) of this section.
 - (ii) Where any employee is exposed to lead above the permissible exposure limit, but for 30 days or less per year, the employer shall implement engineering controls to reduce exposures to $200 \mu\text{g}/\text{m}^3$, but thereafter may implement any combination of engineering, work practice (including administrative controls), and respiratory controls to reduce and maintain employee exposure to lead to or below $50 \mu\text{g}/\text{m}^3$.

TABLE I

Industry	Compliance dates: ¹ (50 µg/m ³)
Lead chemicals, secondary copper smelting	July 19, 1996
Nonferrous foundries.....	July 19, 1996. ²
Brass and bronze ingot manufacture.	6 years. ³

¹Calculated by counting from the date the stay on implementation of paragraph (e)(1) was lifted by the U.S. Court of Appeals for the District of Columbia, the number of years specified in the 1978 lead standard and subsequent amendments for compliance with the PEL of 50 µg/m³ for exposure to airborne concentrations of lead levels for the particular industry.

²Large nonferrous foundries (20 or more employees) are required to achieve the PEL of 50 µg/m³ by means of engineering and work practice controls. Small nonferrous foundries (fewer than 20 employees) are required to achieve an 8-hour TWA of 75 µg/m³ by such controls.

³Expressed as the number of years from the date on that the Court lifts the stay on the implementation of paragraph (e)(1) for this industry for employers to achieve a lead in air concentration of 75 µg/m³. Compliance with paragraph (e) in this industry is determined by a compliance directive that incorporates elements from the settlement agreement between OSHA and representatives of the industry.

- (2) Respiratory protection. Where engineering and work practice controls do not reduce employee exposure to or below the 50 µg/m³ permissible exposure limit, the employer shall supplement these controls with respirators in accordance with paragraph (f).
- (3) Compliance program.
 - (i) Each employer shall establish and implement a written compliance program to reduce exposures to or below the permissible exposure limit, and interim levels if applicable, solely by means of engineering and work practice controls in accordance with the implementation schedule in paragraph (e)(1).
 - (ii) Written plans for these compliance programs shall include at least the following:
 - (A) A description of each operation in that lead is emitted; e.g. machinery used, material processed, controls in place, crew size, employee job responsibilities, operating procedures and maintenance practices;
 - (B) A description of the specific means that will be employed to achieve compliance, including engineering plans and studies used to determine methods selected for controlling exposure to lead;
 - (C) A report of the technology considered in meeting the permissible exposure limit;
 - (D) Air monitoring data that documents the source of lead emissions;
 - (E) A detailed schedule for implementation of the program, including documentation such as copies of purchase orders for equipment, construction contracts, etc.;
 - (F) A work practice program that includes items required under paragraphs (g), (h) and (i) of this regulation;
 - (G) An administrative control schedule required by paragraph (e)(6), if applicable;
 - (H) Other relevant information.
 - (iii) Written programs shall be submitted upon request to the Assistant Secretary and the Director, and shall be available at the worksite for examination and copying by the Assistant Secretary, Director, any affected employee or authorized employee representatives.

- (iv) Written programs must be revised and updated at least annually to reflect the current status of the program.
- (4) Mechanical ventilation.
 - (i) When ventilation is used to control exposure, measurements that demonstrate the effectiveness of the system in controlling exposure, such as capture velocity, duct velocity, or static pressure shall be made at least every 3 months. Measurements of the system's effectiveness in controlling exposure shall be made within 5 days of any change in production, process, or control that might result in a change in employee exposure to lead.
 - (ii) Recirculation of air. If air from exhaust ventilation is recirculated into the workplace, the employer shall assure that (A) the system has a high efficiency filter with reliable backup filter; and (B) controls to monitor the concentration of lead in the return air and to bypass the recirculation system automatically if it fails are installed, operating, and maintained.
- (5) Administrative controls. If administrative controls are used as a means of reducing employee's TWA exposure to lead, the employer shall establish and implement a job rotation schedule that includes:
 - (i) Name or identification number of each affected employee;
 - (ii) Duration and exposure levels at each job or work station where each affected employee is located; and
 - (iii) Any other information that may be useful in assessing the reliability of administrative controls to reduce exposure to lead.
- (f) Respiratory protection.
 - (1) General. For employees who use respirators required by this section, the employer must provide respirators that comply with the requirements of this paragraph. Respirators must be used during:
 - (i) Periods necessary to install or implement engineering or work-practice controls.
 - (ii) Work operations for that engineering and work-practice controls are not sufficient to reduce employee exposures to or below the permissible exposure limit.
 - (iii) Periods when an employee requests a respirator.
 - (2) Respirator program.
 - (i) The employer must implement a respiratory protection program in accordance with 29 CFR 1910.134 (b) through (d) (except (d)(1)(iii)), and (f) through (m).
 - (ii) If an employee has breathing difficulty during fit testing or respirator use, the employer must provide the employee with a medical examination in accordance with paragraph (j)(3)(i)(C) of this section to determine whether or not the employee can use a respirator while performing the required duty.

TABLE II-RESPIRATORY PROTECTION FOR LEAD AEROSOLS

Airborne concentrations of lead or condition of use	Required respirator ¹
Not in excess of 0.5 mg/m ³ (10X PEL)	Half-mask, air-purifying respirator equipped with high efficiency filters. ²³
Not in excess of 2.5 mg/m ³ (50X PEL)	Full facepiece, air-purifying respirator with high efficiency filters. ³
Not in excess of 50 mg/m ³ (1000X PEL)	(1) Any powered, air-purifying respirator with high efficiency filters ³ , or (2) Half-mask supplied-air respirator operated in positive-pressure mode. ²
Not in excess of 100 mg/m ³ (2000X PEL)	Supplied-air respirators with full facepiece, hood, helmet, or suit, operated in positive pressure mode.

Greater than 100 mg/m ³ , unknown concentration or fire fighting.	Full facepiece, self-contained breathing apparatus operated in positive-pressure mode.
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¹Respirators specified for high concentrations can be used at lower concentrations of lead.

²Full facepiece is required if the lead aerosols cause eye or skin irritation at the use concentrations.

³A high efficiency particulate filter means 99.97 percent efficient against 0.3-micron size particles.

- (3) Respirator selection.
 - (i) The employer must select the appropriate respirator or combination of respirators from Table II of this section.
 - (ii) The employer must provide a powered air-purifying respirator instead of the respirator specified in Table II of this section when an employee chooses to use this type of respirator and such a respirator provides adequate protection to the employee.
- (g) Protective work clothing and equipment
 - (1) Provision and use. If an employee is exposed to lead above the PEL, without regard to the use of respirators or where the possibility of skin or eye irritation exists, the employer shall provide at no cost to the employee and assure that the employee uses appropriate protective work clothing and equipment such as, but not limited to:
 - (i) Coveralls or similar full-body work clothing;
 - (ii) Gloves, hats, and shoes or disposable shoe coverlets; and
 - (iii) Face shields, vented goggles, or other appropriate protective equipment that complies with §1910.133 of this Part.
 - (2) Cleaning and replacement.
 - (i) The employer shall provide the protective clothing required in paragraph (g)(1) of this section in a clean and dry condition at least weekly, and daily to employees whose exposure levels without regard to a respirator are over 200 µg/m³ of lead as an 8-hour TWA.
 - (ii) The employer shall provide for the cleaning, laundering, or disposal of protective clothing and equipment required by paragraph (g)(1) of this section.
 - (iii) The employer shall repair or replace required protective clothing and equipment as needed to maintain their effectiveness.
 - (iv) The employer shall assure that all protective clothing is removed at the completion of a work shift only in change rooms provided for that purpose as prescribed in paragraph (i)(2) of this section.
 - (v) The employer shall assure that contaminated protective clothing that is to be cleaned, laundered, or disposed of, is placed in a closed container in the change-room that prevents dispersion of lead outside the container.
 - (vi) The employer shall inform in writing any person who cleans or launders protective clothing or equipment of the potentially harmful effects of exposure to lead.
 - (vii) The employer shall assure that the containers of contaminated protective clothing and equipment required by paragraph (g)(2)(v) are labeled as follows: CAUTION: CLOTHING CONTAMINATED WITH LEAD. DO NOT REMOVE DUST BY BLOWING OR SHAKING. DISPOSE OF LEAD CONTAMINATED WASH WATER IN ACCORDANCE WITH APPLICABLE LOCAL, STATE, OR FEDERAL REGULATIONS.
 - (viii) The employer shall prohibit the removal of lead from protective clothing or equipment by blowing, shaking, or any other means that disperses lead into the air.
- (h) Housekeeping
 - (1) Surfaces. All surfaces shall be maintained as free as practicable of accumulations of lead.
 - (2) Cleaning floors.
 - (i) Floors and other surfaces where lead accumulates may not be cleaned by the use of compressed air.
 - (ii) Shoveling, dry or wet sweeping, and brushing may be used only where vacuuming or other equally effective methods have been tried and found not to be effective.
 - (3) Vacuuming. Where vacuuming methods are selected, the vacuums shall be used and emptied in a manner that minimizes the reentry of lead into the workplace.
- (i) Hygiene facilities and practices.

- (1) The employer shall assure that in areas where employees are exposed to lead above the PEL, without regard to the use of respirators, food or beverage is not present or consumed, tobacco products are not present or used, and cosmetics are not applied, except in change rooms, lunchrooms, and showers required under paragraphs (i)(2) through (i)(4) of this section.
 - (2) Change rooms.
 - (i) The employer shall provide clean change rooms for employees who work in areas where their airborne exposure to lead is above the PEL, without regard to the use of respirators.
 - (ii) The employer shall assure that change rooms are equipped with separate storage facilities for protective work clothing and equipment and for street clothes that prevent cross-contamination.
 - (3) Showers.
 - (i) The employer shall assure that employees who work in areas where their airborne exposure to lead is above the PEL, without regard to the use of respirators, shower at the end of the work shift.
 - (ii) The employer shall provide shower facilities in accordance with §1910.141(d)(3) of this part.
 - (iii) The employer shall assure that employees who are required to shower pursuant to paragraph (i)(3)(i) do not leave the workplace wearing any clothing or equipment worn during the work shift.
 - (4) Lunchrooms.
 - (i) The employer shall provide lunchroom facilities for employees who work in areas where their airborne exposure to lead is above the PEL, without regard to the use of respirators.
 - (ii) The employer shall assure that lunchroom facilities have a temperature controlled, positive pressure, filtered air supply, and are readily accessible to employees.
 - (iii) The employer shall assure that employees who work in areas where their airborne exposure to lead is above the PEL without regard to the use of a respirator wash their hands and face prior to eating, drinking, smoking or applying cosmetics.
 - (iv) The employer shall assure that employees do not enter lunchroom facilities with protective work clothing or equipment unless surface lead dust has been removed by vacuuming, downdraft booth, or other cleaning method.
 - (5) Lavatories. The employer shall provide an adequate number of lavatory facilities that comply with §1910.141(d)(1) and (2) of this Part.
- (j) Medical surveillance**
- (1) General.
 - (i) The employer shall institute a medical surveillance program for all employees who are or may be exposed above the action level for more than 30 days per year.
 - (ii) The employer shall assure that all medical examinations and procedures are performed by or under the supervision of a licensed physician.
 - (iii) The employer shall provide the required medical surveillance including multiple physician review under paragraph (j)(3)(iii) without cost to employees and at a reasonable time and place.
 - (2) Biological monitoring
 - (i) Blood lead and ZPP level sampling and analysis. The employer shall make available biological monitoring in the form of blood sampling and analysis for lead and zinc protoporphyrin levels to each employee covered under paragraph (j)(1)(i) of this section on the following schedule:
 - (A) At least every 6 months to each employee covered under paragraph (j)(1)(i) of this section;
 - (B) At least every two months for each employee whose last blood sampling and analysis indicated a blood lead level at or above 40-µg/100 g of whole blood. This frequency shall continue until two consecutive blood samples and analyses indicate a blood lead level below 40 µg/100 g of whole blood; and
 - (C) At least monthly during the removal period of each employee removed from exposure to lead due to an elevated blood lead level.
 - (ii) Follow-up blood sampling tests. Whenever the results of a blood lead level test indicate that an employee's blood lead level exceeds the numerical criterion for medical removal under paragraph (k)(1)(i)(A) of this section, the employer shall provide a second (follow-up) blood sampling test within two weeks after the employer receives the results of the first blood sampling test.

- (iii) Accuracy of blood lead level sampling and analysis. Blood lead level sampling and analysis provided pursuant to this section shall have an accuracy (to a confidence level of 95 percent) within plus or minus 15 percent or 6 µg/100ml, whichever is greater, and shall be conducted by a laboratory licensed by the Center for Disease Control, United States Department of Health, Education and Welfare (CDC) or that has received a satisfactory grade in blood lead proficiency testing from CDC in the prior twelve months.
 - (iv) Employee notification. Within five working days after the receipt of biological monitoring results, the employer shall notify in writing each employee whose blood lead level exceeds
 - 40 µg/100 g: (A) of that employee's blood lead level and (B) that the standard requires temporary medical removal with Medical Removal Protection benefits when an employee's blood lead level exceeds the numerical criterion for medical removal under paragraph (k)(1)(i) of this section.
- (3) Medical examinations and consultations
 - (i) Frequency. The employer shall make available medical examinations and consultations to each employee covered under paragraph (j)(1)(i) of this section on the following schedule:
 - (A) At least annually for each employee for whom a blood-sampling test conducted at any time during the preceding 12 months indicated a blood lead level at or above 40-µg/100 g;
 - (B) Prior to assignment for each employee being assigned for the first time to an area in that airborne concentrations of lead are at or above the action level;
 - (C) As soon as possible, upon notification by an employee either that the employee has developed signs or symptoms commonly associated with lead intoxication, that the employee desires medical advice concerning the effects of current or past exposure to lead on the employee's ability to procreate a healthy child, or that the employee has demonstrated difficulty in breathing during a respirator fitting test or during use; and
 - (D) As medically appropriate for each employee either removed from exposure to lead due to a risk of sustaining material impairment to health, or otherwise limited pursuant to a final medical determination.
 - (ii) Content. Medical examinations made available pursuant to paragraph (j)(3)(i)(A)-(B) of this section shall include the following elements:
 - (A) A detailed work history and a medical history, with particular attention to past lead exposure (occupational and non-occupational), personal habits (smoking, hygiene), and past gastrointestinal, hematologic, renal, cardiovascular, reproductive and neurological problems;
 - (B) A thorough physical examination, with particular attention to teeth, gums, hematologic, gastrointestinal, renal, cardiovascular, and neurological systems. Pulmonary status should be evaluated if respiratory protection will be used;
 - (C) A blood pressure measurement;
 - (D) A blood sample and analysis that determines:
 - (1) Blood lead level;
 - (2) Hemoglobin and hematocrit determinations, red cell indices, and examination of peripheral smear morphology;
 - (3) Zinc protoporphyrin;
 - (4) Blood urea nitrogen; and,
 - (5) Serum creatinine;
 - (E) A routine urinalysis with microscopic examination; and
 - (F) Any laboratory or other test that the examining physician deems necessary by sound medical practice. The content of medical examinations made available pursuant to paragraph (j)(3)(i)(C) - (D) of this section shall be determined by an examining physician and, if requested by an employee, shall include pregnancy testing or laboratory evaluation of male fertility.
 - (iii) Multiple physician review mechanism.
 - (A) If the employer selects the initial physician who conducts any medical examination or consultation provided to an employee under this section, the employee may designate a second physician:
 - (1) To review any findings, determinations or recommendations of the initial physician; and

- (2) To conduct such examinations, consultations, and laboratory tests as the second physician deems necessary to facilitate this review.
 - (B) The employer shall promptly notify an employee of the right to seek a second medical opinion after each occasion that an initial physician conducts a medical examination or consultation pursuant to this section. The employer may condition its participation in, and payment for, the multiple physician review mechanism upon the employee doing the following within fifteen (15) days after receipt of the foregoing notification, or receipt of the initial physician's written opinion, whichever is later:
 - (1) The employee informing the employer that he or she intends to seek a second medical opinion, and
 - (2) The employee initiating steps to make an appointment with a second physician.
 - (C) If the findings, determinations or recommendations of the second physician differ from those of the initial physician, then the employer and the employee shall assure that efforts are made for the two physicians to resolve any disagreement.
 - (D) If the two physicians have been unable to quickly resolve their disagreement, then the employer and the employee through their respective physicians shall designate a third physician:
 - (1) To review any findings, determinations or recommendations of the prior physicians; and
 - (2) To conduct such examinations, consultations, laboratory tests and discussions with the prior physicians as the third physician deems necessary to resolve the disagreement of the prior physicians.
 - (E) The employer shall act consistent with the findings, determinations and recommendations of the third physician, unless the employer and the employee reach an agreement that is otherwise consistent with the recommendations of at least one of the three physicians.
- (iv) Information provided to examining and consulting physicians.
 - (A) The employer shall provide an initial physician conducting a medical examination or consultation under this section with the following information:
 - (1) A copy of this regulation for lead including all Appendices;
 - (2) A description of the affected employee's duties as they relate to the employee's exposure;
 - (3) The employee's exposure level or anticipated exposure level to lead and to any other toxic substance (if applicable);
 - (4) A description of any personal protective equipment used or to be used;
 - (5) Prior blood lead determinations; and
 - (6) All prior written medical opinions concerning the employee in the employer's possession or control.
 - (B) The employer shall provide the foregoing information to a second or third physician conducting a medical examination or consultation under this section upon request either by the second or third physician, or by the employee.
- (v) Written medical opinions.
 - (A) The employer shall obtain and furnish the employee with a copy of a written medical opinion from each examining or consulting physician that contains the following information:
 - (1) The physician's opinion as to whether the employee has any detected medical condition that would place the employee at increased risk of material impairment of the employee's health from exposure to lead;
 - (2) Any recommended special protective measures to be provided to the employee, or limitations to be placed upon the employee's exposure to lead;
 - (3) Any recommended limitation upon the employee's use of respirators, including a determination of whether the employee can wear a powered air purifying respirator if a physician determines that the employee cannot wear a negative pressure respirator; and
 - (4) The results of the blood lead determinations.
 - (B) The employer shall instruct each examining and consulting physician to:
 - (1) Not reveal either in the written opinion, or in any other means of communication with the employer, findings, including laboratory results, or diagnoses unrelated to an employee's occupational exposure to lead; and

- (2) Advise the employee of any medical condition, occupational or non-occupational, that dictates further medical examination or treatment.
- (vi) Alternate Physician Determination Mechanisms. The employer and an employee or authorized employee representative may agree upon the use of any expeditious alternate physician determination mechanism in lieu of the multiple physician review mechanism provided by this paragraph so long as the alternate mechanism otherwise satisfies the requirements contained in this paragraph.
- (4) Chelation.
 - (i) The employer shall assure that any person whom he retains, employs, supervises or controls does not engage in prophylactic chelation of any employee at any time.
 - (ii) If therapeutic or diagnostic chelation is to be performed by any person in paragraph (j)(4)(i), the employer shall assure that it be done under the supervision of a licensed physician in a clinical setting with thorough and appropriate medical monitoring and that the employee is notified in writing prior to its occurrence.
- (k) Medical Removal Protection**
 - (1) Temporary medical removal and return of an employee
 - (i) Temporary removal due to elevated blood lead levels
 - (A) The employer shall remove an employee from work having an exposure to lead at or above the action level on each occasion that a periodic and a follow-up blood sampling test conducted pursuant to this section indicate that the employee's blood lead level is at or above 60 µg/100 g of whole blood; and,
 - (B) The employer shall remove an employee from work having an exposure to lead at or above the action level on each occasion that the average of the last three blood sampling tests conducted pursuant to this section (or the average of all blood sampling tests conducted over the previous six (6) months, whichever is longer) indicates that the employee's blood lead level is at or above 50 µg/100 g of whole blood; provided, however, that an employee need not be removed if the last blood sampling test indicates a blood lead level at or below 40 µg/100 g of whole blood.
 - (ii) Temporary removal due to a final medical determination.
 - (A) The employer shall remove an employee from work having an exposure to lead at or above the action level on each occasion that a final medical determination results in a medical finding, determination, or opinion that the employee has a detected medical condition that places the employee at increased risk of material impairment to health from exposure to lead.
 - (B) For the purposes of this section, the phrase "final medical determination" shall mean the outcome of the multiple physician review mechanism or alternate medical determination mechanism used pursuant to the medical surveillance provisions of this section.
 - (C) Where a final medical determination results in any recommended special protective measures for an employee, or limitations on an employee's exposure to lead, the employer shall implement and act consistent with the recommendation.
 - (iii) Return of the employee to former job status.
 - (A) The employer shall return an employee to his or her former job status:
 - (1) For an employee removed due to a blood lead level at or above 60 µg/100 g, or due to an average blood lead level at or above 50 µg/100 g, when two consecutive blood sampling tests indicate that the employee's blood lead level is at or below 40 µg/100 g of whole blood;
 - (2) For an employee removed due to a final medical determination, when a subsequent final medical determination results in a medical finding, determination, or opinion that the employee no longer has a detected medical condition that places the employee at increased risk of material impairment to health from exposure to lead.
 - (B) For the purposes of this section, the requirement that an employer return an employee to his or her former job status is not intended to expand upon or restrict any rights an employee has or would have had, absent temporary medical removal, to a specific job classification or position under the terms of a collective bargaining agreement.
 - (iv) Removal of other employee special protective measure or limitations. The employer shall remove any limitations placed on an employee or end any special protective measures provided to an employee pursuant to a final medical determination when a subsequent

final medical determination indicates that the limitations or special protective measures are no longer necessary.

- (v) Employer options pending a final medical determination. Where the multiple physician review mechanism, or alternate medical determination mechanism used pursuant to the medical surveillance provisions of this section, has not yet resulted in a final medical determination with respect to an employee, the employer shall act as follows:
 - (A) Removal. The employer may remove the employee from exposure to lead, provide special protective measures to the employee, or place limitations upon the employee, consistent with the medical findings, determinations, or recommendations of any of the physicians who have reviewed the employee's health status.
 - (B) Return. The employer may return the employee to his or her former job status, end any special protective measures provided to the employee, and remove any limitations placed upon the employee, consistent with the medical findings, determinations, or recommendations of any of the physicians who have reviewed the employee's health status, with two exceptions. If (1) the initial removal, special protection, or limitation of the employee resulted from a final medical determination that differed from the findings, determinations, or recommendations of the initial physician or (2) the employee has been on removal status for the preceding eighteen months due to an elevated blood lead level, then the employer shall await a final medical determination.
- (2) Medical removal protection benefits
 - (i) Provision of medical removal protection benefits. The employer shall provide to an employee up to eighteen (18) months of medical removal protection benefits on each occasion that an employee is removed from exposure to lead or otherwise limited pursuant to this section.
 - (ii) Definition of medical removal protection benefits. For the purposes of this section, the requirement that an employer provide medical removal protection benefits means that the employer shall maintain the earnings, seniority and other employment rights and benefits of an employee as though the employee had not been removed from normal exposure to lead or otherwise limited.
 - (iii) Follow-up medical surveillance during the period of employee removal or limitation. During the period of time that an employee is removed from normal exposure to lead or otherwise limited, the employer may condition the provision of medical removal protection benefits upon the employee's participation in follow-up medical surveillance made available pursuant to this section.
 - (iv) Workers' compensation claims. If a removed employee files a claim for workers' compensation payments for a lead-related disability, then the employer shall continue to provide medical removal protection benefits pending disposition of the claim. To the extent that an award is made to the employee for earnings lost during the period of removal, the employer's medical removal protection obligation shall be reduced by such amount. The employer shall receive no credit for workers' compensation payments received by the employee for treatment related expenses.
 - (v) Other credits. The employer's obligation to provide medical removal protection benefits to a removed employee shall be reduced to the extent that the employee receives compensation for earnings lost during the period of removal either from a publicly or employer-funded compensation program, or receives income from employment with another employer made possible by virtue of the employee's removal.
 - (vi) Employees whose blood lead levels do not adequately decline within 18 months of removal. The employer shall take the following measures with respect to any employee removed from exposure to lead due to an elevated blood lead level whose blood lead level has not declined within the past eighteen (18) months of removal so that the employee has been returned to his or her former job status:
 - (A) The employer shall make available to the employee a medical examination pursuant to this section to obtain a final medical determination with respect to the employee;
 - (B) The employer shall assure that the final medical determination obtained indicates whether or not the employee may be returned to his or her former job status, and if not, what steps should be taken to protect the employee's health;
 - (C) Where the final medical determination has not yet been obtained, or once obtained indicates that the employee may not yet be returned to his or her former job status,

the employer shall continue to provide medical removal protection benefits to the employee until either the employee is returned to former job status, or a final medical determination is made that the employee is incapable of ever safely returning to his or her former job status.

- (D) Where the employer acts pursuant to a final medical determination that permits the return of the employee to his or her former job status despite what would otherwise be an unacceptable blood lead level, later questions concerning removing the employee again shall be decided by a final medical determination. The employer need not automatically remove such an employee pursuant to the blood lead level removal criteria provided by this section.
- (vii) Voluntary Removal or Restriction of An Employee. Where an employer, although not required by this section to do so, removes an employee from exposure to lead or otherwise places limitations on an employee due to the effects of lead exposure on the employee's medical condition, the employer shall provide medical removal protection benefits to the employee equal to that required by paragraph (k)(2)(i) of this section.
- (l) Employee information and training**
 - (1) Training program.
 - (i) Each employer who has a workplace in that there is a potential exposure to airborne lead at any level shall inform employees of the content of Appendices A and B of this regulation.
 - (ii) The employer shall institute a training program for and assure the participation of all employees who are subject to exposure to lead at or above the action level or for whom the possibility of skin or eye irritation exists.
 - (iii) The employer shall provide initial training by 180 days from the effective date for those employees covered by paragraph (l)(1)(ii) on the standard's effective date and prior to the time of initial job assignment for those employees subsequently covered by this paragraph.
 - (iv) The training program shall be repeated at least annually for each employee.
 - (v) The employer shall assure that each employee is informed of the following:
 - (A) The content of this standard and its appendices;
 - (B) The specific nature of the operations that could result in exposure to lead above the action level;
 - (C) The purpose, proper selection, fitting, use, and limitations of respirators;
 - (D) The purpose and a description of the medical surveillance program, and the medical removal protection program including information concerning the adverse health effects associated with excessive exposure to lead (with particular attention to the adverse reproductive effects on both males and females);
 - (E) The engineering controls and work practices associated with the employee's job assignment;
 - (F) The contents of any compliance plan in effect; and
 - (G) Instructions to employees that chelating agents should not routinely be used to remove lead from their bodies and should not be used at all except under the direction of a licensed physician;
 - (2) Access to information and training materials.
 - (i) The employer shall make readily available to all affected employees a copy of this standard and its appendices.
 - (ii) The employer shall provide, upon request, all materials relating to the employee information and training program to the Assistant Secretary and the Director.
 - (iii) In addition to the information required by paragraph (l)(1)(v), the employer shall include as part of the training program, and shall distribute to employees, any materials pertaining to the Occupational Safety and Health Act, the regulations issued pursuant to that Act, and this lead standard, that are made available to the employer by the Assistant Secretary.
- (m) Signs**
 - (1) General.
 - (i) The employer may use signs required by other statutes, regulations or ordinances in addition to, or in combination with, signs required by this paragraph.
 - (ii) The employer shall assure that no statement appears on or near any sign required by this paragraph that contradicts or detracts from the meaning of the required sign.
 - (2) Signs.

- (i) The employer shall post the following warning signs in each work area where the PEL is exceeded:

WARNING
LEAD WORK AREA
POISON
NO SMOKING OR EATING

- (ii) The employer shall assure that signs required by this paragraph are illuminated and cleaned as necessary so that the legend is readily visible.

(n) Record Keeping

(1) Exposure monitoring.

- (i) The employer shall establish and maintain an accurate record of all monitoring required in paragraph (d) of this section.
- (ii) This record shall include:
 - (A) The date(s), number, duration, location and results of each of the samples taken, including a description of the sampling procedure used to determine representative employee exposure where applicable;
 - (B) A description of the sampling and analytical methods used and evidence of their accuracy;
 - (C) The type of respiratory protective devices worn, if any;
 - (D) Name, social security number, and job classification of the employee monitored and of all other employees whose exposure the measurement is intended to represent; and
 - (E) The environmental variables that could affect the measurement of employee exposure.
- (iii) The employer shall maintain these monitoring records for at least 40 years or for the duration of employment plus 20 years, whichever is longer.

(2) Medical surveillance.

- (i) The employer shall establish and maintain an accurate record for each employee subject to medical surveillance as required by paragraph (j) of this section.
- (ii) This record shall include:
 - (A) The name, social security number, and description of the duties of the employee;
 - (B) A copy of the physician's written opinions;
 - (C) Results of any airborne exposure monitoring done for that employee and the representative exposure levels supplied to the physician; and
 - (D) Any employee medical complaints related to exposure to lead.
- (iii) The employer shall keep, or assure that the examining physician keeps, the following medical records:
 - (A) A copy of the medical examination results including medical and work history required under paragraph (j) of this section;
 - (B) A description of the laboratory procedures and a copy of any standards or guidelines used to interpret the test results or references to that information;
 - (C) A copy of the results of biological monitoring.
- (iv) The employer shall maintain or assure that the physician maintains those medical records for at least 40 years, or for the duration of employment plus 20 years, whichever is longer.

(3) Medical removals.

- (i) The employer shall establish and maintain an accurate record for each employee removed from current exposure to lead pursuant to paragraph (k) of this section.
- (ii) Each record shall include:
 - (A) The name and social security number of the employee;
 - (B) The date on each occasion that the employee was removed from current exposure to lead as well as the corresponding date on that the employee was returned to his or her former job status;
 - (C) A brief explanation of how each removal was or is being accomplished; and
 - (D) A statement with respect to each removal indicating whether or not the reason for the removal was an elevated blood lead level.
- (iii) The employer shall maintain each medical removal record for at least the duration of an employee's employment.

(4) Availability.

- (i) The employer shall make available upon request all records required to be maintained by paragraph (n) of this section to the Assistant Secretary and the Director for examination and copying.
 - (ii) Environmental monitoring, medical removal, and medical records required by this paragraph shall be provided upon request to employees, designated representatives, and the Assistant Secretary in accordance with 29 CFR 1910.20 (a) - (e) and (g) - (i). Medical removal records shall be provided in the same manner as environmental monitoring records.
- (5) Transfer of records.
 - (i) Whenever the employer ceases to do business, the successor employer shall receive and retain all records required to be maintained by paragraph (n) of this section.
 - (ii) Whenever the employer ceases to do business and there is no successor employer to receive and retain the records required to be maintained by this section for the prescribed period, these records shall be transmitted to the Director.
 - (iii) At the expiration of the retention period for the records required to be maintained by this section, the employer shall notify the Director at least 3 months prior to the disposal of such records and shall transmit those records to the Director if requested within the period.
 - (iv) The employer shall also comply with any additional requirements involving transfer of records set forth in 29 CFR 1910.20(h).
- (o) Observation of monitoring.
 - (1) Employee observation. The employer shall provide affected employees or their designated representatives an opportunity to observe any monitoring of employee exposure to lead conducted pursuant to paragraph (d) of this section.
 - (2) Observation procedures.
 - (i) Whenever observation of the monitoring of employee exposure to lead requires entry into an area where the use of respirators, protective clothing or equipment is required, the employer shall provide the observer with and assure the use of such respirators, clothing and such equipment, and shall require the observer to comply with all other applicable safety and health procedures.
 - (ii) Without interfering with the monitoring, observers shall be entitled to:
 - (A) Receive an explanation of the measurement procedures;
 - (B) Observe all steps related to the monitoring of lead performed at the place of exposure; and
 - (C) Record the results obtained or receive copies of the results when returned by the laboratory.
- (p) Effective date. This standard shall become effective March 1, 1979.
- (q) Appendices. The information contained in the appendices to this section is not intended by itself, to create any additional obligations not otherwise imposed by this standard nor detract from any existing obligation.
- (r) Startup dates. All obligations of this standard commence on the effective date except as follows:
 - (1) The initial determination under paragraph (d)(2) shall be made as soon as possible but no later than 30 days from the effective date.
 - (2) Initial monitoring under paragraph (d)(4) shall be completed as soon as possible but no later than 90 days from the effective date.
 - (3) Initial biological monitoring and medical examinations under paragraph (j) shall be completed as soon as possible but no later than 180 days from the effective date. Priority for biological monitoring and medical examinations shall be given to employees whom the employer believes to be at greatest risk from continued exposure.
 - (4) Initial training and education shall be completed as soon as possible but no later than 180 days from the effective date.
 - (5) Hygiene and lunchroom facilities under paragraph (i) shall be in operation as soon as possible but no later than 1 year from the effective year.
 - (6) Respiratory protection required by paragraph (f) shall be provided as soon as possible but no later than the following schedule:
 - (A) Employees whose 8-hour TWA exposure exceeds $200 \mu\text{g}/\text{m}^3$ on the effective date.
 - (B) Employees whose 8-hour TWA exposure exceeds the PEL but is less than $200 \mu\text{g}/\text{m}^3$ - 150 days from the effective date.
 - (C) Powered, air-purifying respirators provided under (f)(2)(ii) - 210 days from the effective date.

- (D) Quantitative fit testing required under (f)(3)(ii)-one year from effective date. Qualitative fit testing is required in the interim.
- (7) (i) Written compliance plans required by paragraph (e)(3) shall be completed and available for inspection and copying as soon as possible but no later than the following schedule:
 - (A) Employers for whom compliance with the PEL or interim level is required within 1 year from the effective date-6 months from the effective date.
 - (B) Employers in secondary lead smelting and refining and in lead storage battery manufacturing-1 year from the effective date.
 - (C) Employers in primary smelting and refining industry-1 year from the effective date for the interim level; 5 years from the effective date for PEL.
 - (D) Plans for construction of hygiene facilities, if required-6 months from the effective date.
- (8) The permissible exposure limit in paragraph (c) shall become effective 150 days from the effective date.

APPENDIX A to Section 1910.1025 SUBSTANCE DATA SHEET FOR OCCUPATIONAL EXPOSURE TO LEAD

I. SUBSTANCE IDENTIFICATION

- A. Substance: Pure lead (Pb) is a heavy metal at room temperature and pressure and is a basic chemical element. It can combine with various other substances to form numerous lead compounds.
- B. Compounds Covered by the Standard: The word "lead" when used in this standard means elemental lead, all inorganic lead compounds and a class of organic lead compounds called lead soaps. This standard does not apply to other organic lead compounds.
- C. Uses: Exposure to lead occurs in at least 120 different occupations, including primary and secondary lead smelting, lead storage battery manufacturing, lead pigment manufacturing and use, solder manufacturing and use, shipbuilding and ship repairing, auto manufacturing, and printing.
- D. Permissible Exposure: The Permissible Exposure Limit (PEL) set by the standard is 50 micrograms of lead per cubic meter of air ($50 \mu\text{g}/\text{m}^3$), averaged over an 8-hour workday.
- E. Action Level: The standard establishes an action level of 30 micrograms per cubic meter of air ($30 \mu\text{g}/\text{m}^3$), time weighted average, based on an 8-hour workday. The action level initiates several requirements of the standard, such as exposure monitoring, medical surveillance, and training and education.

II. HEALTH HAZARD DATA

- A. Ways in that lead enters your body. When absorbed into your body in certain doses lead is a toxic substance. The object of the lead standard is to prevent absorption of harmful quantities of lead. The standard is intended to protect you not only from the immediate toxic effects of lead, but also from the serious toxic effects that may not become apparent until years of exposure have passed.
 Lead can be absorbed into your body by inhalation (breathing) and ingestion (eating). Lead (except for certain organic lead compounds not covered by the standard, such as tetraethyl lead) is not absorbed through your skin. When lead is scattered in the air as a dust, fume or mist it can be inhaled and absorbed through you lungs and upper respiratory tract. Inhalation of airborne lead is generally the most important source of occupational lead absorption. You can also absorb lead through your digestive system if lead gets into your mouth and is swallowed. If you handle food, cigarettes, chewing tobacco, or make-up that have lead on them or handle them with hands contaminated with lead, this will contribute to ingestion.

A significant portion of the lead that you inhale or ingest gets into your blood stream. Once in your blood stream, lead is circulated throughout your body and stored in various organs and body tissues. Some of this lead is quickly filtered out of your body and excreted, but some remains in the

blood and other tissues. As exposure to lead continues, the amount stored in your body will increase if you are absorbing more lead than your body is excreting. Even though you may not be aware of any immediate symptoms of disease, this lead stored in your tissues can be slowly causing irreversible damage, first to individual cells, then to your organs and whole body systems.

B. Effects of overexposure to lead

- (1) Short term (acute) overexposure. Lead is a potent, systemic poison that serves no known useful function once absorbed by your body. Taken in large enough doses, lead can kill you in a matter of days. A condition affecting the brain called acute encephalopathy may arise that develops quickly to seizures, coma, and death from cardiorespiratory arrest. A short-term dose of lead can lead to acute encephalopathy. Short-term occupational exposures of this magnitude are highly unusual, but not impossible. Similar forms of encephalopathy may, however, arise from extended, chronic exposure to lower doses of lead. There is no sharp dividing line between rapidly developing acute effects of lead, and chronic effects that take longer to acquire. Lead adversely affects numerous body systems, and causes forms of health impairment and disease that arise after periods of exposure as short as days or as long as several years.
- (2) Long-term (chronic) overexposure. Chronic overexposure to lead may result in severe damage to your blood-forming, nervous, urinary and reproductive systems. Some common symptoms of chronic overexposure include loss of appetite, metallic taste in the mouth, anxiety, constipation, nausea, pallor, excessive tiredness, weakness, insomnia, headache, nervous irritability, muscle and joint pain or soreness, fine tremors, numbness, dizziness, hyperactivity and colic. In lead colic there may be severe abdominal pain.

Damage to the central nervous system in general and the brain (encephalopathy) in particular is one of the most severe forms of lead poisoning. The most severe, often fatal, form of encephalopathy may be preceded by vomiting, a feeling of dullness progressing to drowsiness and stupor, poor memory, restlessness, irritability, tremor, and convulsions. It may arise suddenly with the onset of seizures, followed by coma, and death. There is a tendency for muscular weakness to develop at the same time. This weakness may progress to paralysis often observed as a characteristic "wrist drop" or "foot drop" and is a manifestation of a disease to the nervous system called peripheral neuropathy.

Chronic overexposure to lead also results in kidney disease with few, if any, symptoms appearing until extensive and most likely permanent kidney damage has occurred. Routine laboratory tests reveal the presence of this kidney disease only after about two-thirds of kidney function is lost. When overt symptoms of urinary dysfunction arise, it is often too late to correct or prevent worsening conditions, and progression to kidney dialysis or death is possible.

Chronic overexposure to lead impairs the reproductive systems of both men and women. Overexposure to lead may result in decreased sex drive, impotence and sterility in men. Lead can alter the structure of sperm cells raising the risk of birth defects. There is evidence of miscarriage and stillbirth in women whose husbands were exposed to lead or who were exposed to lead themselves. Lead exposure also may result in decreased fertility, and abnormal menstrual cycles in women. The course of pregnancy may be adversely affected by exposure to lead since lead crosses the placental barrier and poses risks to developing fetuses. Children born of parents either one of whom were exposed to excess lead levels are more likely to have birth defects, mental retardation, behavioral disorders or die during the first year of childhood.

Overexposure to lead also disrupts the blood-forming system resulting in decreased hemoglobin (the substance in the blood that carries oxygen to the cells) and ultimately anemia. Anemia is characterized by weakness, pallor and fatigability as a result of decreased oxygen carrying capacity in the blood.

- (3) Health protection goals of the standard. Prevention of adverse health effects for most workers from exposure to lead throughout a working lifetime requires that worker blood lead (PbB) levels be maintained at or below forty micrograms per one hundred grams of whole blood 40

µg/100g). The blood lead levels of workers (both male and female workers) who intend to have children should be maintained below 30 µg/100g to minimize adverse reproductive health effects to the parents and to the developing fetus.

The measurement of your blood lead level is the most useful indicator of the amount of lead being absorbed by your body. Blood lead levels (PbB) are most often reported in units of milligrams (mg) or micrograms (µg) of lead (1 mg=1000 µg) per 100 grams (100g), 100 milliliters (100 ml) or deciliter (dl) of blood. These three units are essentially the same. Sometime PbB's are expressed in the form of mg% or µg%. This is a shorthand notation for 100g, 100 ml, or dl.

PbB measurements show the amount of lead circulating in your blood stream, but do not give any information about the amount of lead stored in your various tissues. PbB measurements merely show current absorption of lead, not the effect that lead is having on your body or the effects that past lead exposure may have already caused. Past research into lead-related diseases, however, has focused heavily on associations between PbBs and various diseases. As a result, your PbB is an important indicator of the likelihood that you will gradually acquire a lead-related health impairment or disease.

Once your blood lead level climbs above 40 µg/100g, your risk of disease increases. There is a wide variability of individual response to lead, thus it is difficult to say that a particular PbB in a given person will cause a particular effect. Studies have associated fatal encephalopathy with PbBs as low as 150 µg/100g. Other studies have shown other forms of diseases in some workers with PbBs well below 80 µg/100g. Your PbB is a crucial indicator of the risks to your health, but one other factor is also extremely important. This factor is the length of time you have had elevated PbBs. The longer you have an elevated PbB, the greater the risk that large quantities of lead are being gradually stored in your organs and tissues (body burden). The greater your overall body burden, the greater the chances of substantial permanent damage.

The best way to prevent all forms of lead-related impairments and diseases-both short term and long term- is to maintain your PbB below 40 µg/100g. The provisions of the standard are designed with this end in mind. Your employer has prime responsibility to assure that the provisions of the standard are complied with both by the company and by individual workers. You as a worker, however, also have a responsibility to assist your employer in complying with the standard. You can play a key role in protecting your own health by learning about the lead hazards and their control, learning what the standard requires, following the standard where it governs your own actions, and seeing that your employer complies with provisions governing his actions.

- (4) Reporting signs and symptoms of health problems. You should immediately notify your employer if you develop signs or symptoms associated with lead poisoning or if you desire medical advice concerning the effects of current or past exposure to lead on your ability to have a healthy child. You should also notify your employer if you have difficulty breathing during a respirator fit test or while wearing a respirator. In each of these cases your employer must make available to you appropriate medical examinations or consultations. These must be provided at no cost to you and at a reasonable time and place.

The standard contains a procedure whereby you can obtain a second opinion by a physician of your choice if the employer selected the initial physician.

APPENDIX B to Section 1910.1025 EMPLOYEE STANDARD SUMMARY

This appendix summarizes key provisions of the standard that you as a worker should become familiar with.

I. PERMISSIBLE EXPOSURE LIMIT (PEL) -

PARAGRAPH (C)

The standard sets a permissible exposure limit (PEL) of fifty micrograms of lead per cubic meter of air ($50 \mu\text{g}/\text{m}^3$), averaged over an 8-hour workday. This is the highest level of lead in air to that you may be permissibly exposed over an 8-hour workday. Since it is an 8-hour average it permits short exposures above the PEL so long as for each 8-hour workday your average exposure does not exceed the PEL.

This standard recognizes that your daily exposure to lead can extend beyond a typical 8-hour workday as the result of overtime or other alterations in your work schedule. To deal with this, the standard contains a formula that reduces your permissible exposure when you are exposed more than 8 hours. For example, if you are exposed to lead for 10 hours a day, the maximum permitted average exposure would be $40 \mu\text{g}/\text{m}^3$.

II. EXPOSURE MONITORING -
PARAGRAPH (D)

If lead is present in the workplace where you work in any quantity, your employer is required to make an initial determination of whether the action level is exceeded for any employee. This initial determination must include instrument monitoring of the air for the presence of lead and must cover the exposure of a representative number of employees who are reasonably believed to have the highest exposure levels. If your employer has conducted appropriate air sampling for lead in the past year he may use these results. If there have been any employee complaints of symptoms that may be attributable to exposure to lead or if there is any other information or observations that would indicate employee exposure to lead, this must also be considered as part of the initial determination. This initial determination must have been completed by March 31, 1979. If this initial determination shows that a reasonable possibility exists that any employee may be exposed, without regard to respirators, over the action level ($30 \mu\text{g}/\text{m}^3$) your employer must set up an air-monitoring program to determine the exposure level of every employee exposed to lead at your workplace.

In carrying out this air monitoring program, your employer is not required to monitor the exposure of every employee, but he must monitor a representative number of employees and job types. Enough sampling must be done to enable each employee's exposure level to be reasonably represented by at least one full shift (at least 7 hours) air sample. In addition, these air samples must be taken under conditions that represent each employee's regular, daily exposure to lead. All initial exposure monitoring must have been completed by May 30, 1979.

If you are exposed to lead and air sampling is performed, your employer is required to quickly notify you in writing of air monitoring results that represent your exposure. If the results indicate your exposure exceeds the PEL (without regard to your use of respirators), then your employer must also notify you of this in writing, and provide you with a description of the corrective action that will be taken to reduce your exposure.

Your exposure must be rechecked by monitoring every six months if your exposure is over the action level but below the PEL. Air monitoring must be repeated every 3 months if you are exposed over the PEL. Your employer may discontinue monitoring for you if 2 consecutive measurements, taken at least two weeks apart, are below the action level. However, whenever there is a production, process, control, or personnel change at your workplace that may result in new or additional exposure to lead, or whenever there is any other reason to suspect a change that may result in new or additional exposure to lead, your employer must perform additional monitoring.

III. METHODS OF COMPLIANCE -
PARAGRAPH (E)

Your employer is required to assure that no employee is exposed to lead in excess of the PEL. The standard establishes a priority of methods to be used to meet the PEL.

IV. RESPIRATORY PROTECTION - PARAGRAPH (F)

Your employer is required to provide and assure your use of respirators when your exposure to lead is not controlled below the PEL by other means. The employer must pay the cost of the respirator. Whenever you request one, your employer is also required to provide you a respirator even if your air exposure level does not exceed the PEL. You might desire a respirator when, for example, you have received medical advice that your lead absorption should be decreased. Or, you may intend to have children in the near future, and want to reduce the level of lead in your body to minimize adverse reproductive effects. While respirators are the least satisfactory means of controlling your exposure, they are capable of providing significant protection if properly chosen, fitted, worn, cleaned, maintained, and replaced when they stop providing adequate protection.

Your employer is required to select respirators from the seven types listed in Table II of the Respiratory Protection section of the standard (§1910.1025(f)). Any respirator chosen must be approved by the National Institute for Occupational Safety and Health (NIOSH) under the provisions of 42 CFR part 84. This respirator selection table will enable your employer to choose a type of respirator that will give you a proper amount of protection based on your airborne lead exposure. Your employer may select a type of respirator that provides greater protection than that required by the standard; that is, one recommended for a higher concentration of lead than is present in your workplace. For example, a powered air-purifying respirator (PAPR) is much more protective than a typical negative pressure respirator, and may also be more comfortable to wear. A PAPR has a filter, cartridge, or canister to clean the air, and a power source that continuously blows filtered air into your breathing zone. Your employer might make a PAPR to wear a respirator for long periods of time. The standard provides that you can obtain a PAPR upon request.

Your employer must also start a Respiratory Protection Program. This program must include written procedures for the proper selection, use, cleaning, storage, and maintenance of respirators.

Your employer must ensure that your respirator facepiece fits properly. Proper fit of a respirator facepiece is critical to your protection from airborne lead. Obtaining a proper fit on each employee may require your employer to make available several different types of respirator masks. To ensure that your respirator fits properly and that facepiece leakage is minimal, your employer must give you either a qualitative or quantitative fit test as specified in Appendix a of the Respiratory Protection standard located at 29 CFR 1910.134.

You must also receive from your employer proper training in the use of respirators. Your employer is required to teach you how to wear a respirator, to know why it is needed, and to understand its limitations.

The standard provides that if your respirator uses filter elements, you must be given an opportunity to change the filter elements whenever an increase in breathing resistance is detected. You also must be permitted to periodical facepiece whenever necessary to prevent skin irritation. If you ever have difficulty in breathing during a fit test or while using a respirator, your employer must make a medical examination available to you to determine whether you can safely wear a respirator. The result of this examination may be to give you a positive pressure respirator (that reduces breathing resistance) or to provide alternative means of protection.

V. PROTECTIVE WORK CLOTHING AND EQUIPMENT - PARAGRAPH (G)

If you are exposed to lead above the PEL, or if you are exposed to lead compounds such as lead arsenate or lead azide that can cause skin and eye irritation, your employer must provide you with protective work clothing and equipment appropriate for the hazard. If work clothing is provided, it must be provided in a clean and dry condition at least weekly, and daily if your airborne exposure to lead is greater than 200 µg/m³. Appropriate protective work clothing and equipment can include coveralls or similar full-body work clothing, gloves, hats, shoes or disposable shoe coverlets, and face shields or vented goggles. Your employer is required to provide all such equipment at no cost to you. He is responsible for providing

repairs and replacement as necessary, and also is responsible for the cleaning, laundering or disposal of protective clothing and equipment. Contaminated work clothing or equipment must be removed in change rooms and not worn home or you will extend your exposure and expose your family since lead from your clothing can accumulate in your house, car, etc. Contaminated clothing that is to be cleaned, laundered or disposed of must be placed in closed containers in the change room. At no time may lead be removed from protective clothing or equipment by any means that disperses lead into the workroom air.

VI. HOUSEKEEPING - PARAGRAPH (H)

Your employer must establish a housekeeping program sufficient to maintain all surfaces as free as practicable of accumulations of lead dust. Vacuuming is the preferred method of meeting this requirement, and the use of compressed air to clean floors and other surfaces is absolutely prohibited. Dry or wet sweeping, shoveling, or brushing may not be used except where vacuuming or other equally effective methods have been tried and do not work. Vacuums must be used and emptied in a manner that minimizes the reentry of lead into the workplace.

VII. HYGIENE FACILITIES AND PRACTICES - PARAGRAPH (I)

The standard requires that change rooms, showers, and filtered air lunchrooms be constructed and made available to workers exposed to lead above the PEL. When the PEL is exceeded the employer must assure that food and beverage is not present or consumed, tobacco products are not present or used, and cosmetics are not applied, except in these facilities. Change rooms, showers, and lunchrooms, must be used by workers exposed in excess of the PEL. After showering, no clothing or equipment worn during the shift may be worn home, and this includes shoes and underwear. Your own clothing worn during the shift should be carried home and cleaned carefully so that it does not contaminate your home. Lunchrooms may not be entered with protective clothing or equipment unless surface dust has been removed by vacuuming, downdraft booth, or other cleaning method. Finally, workers exposed above the PEL must wash both their hands and faces prior to eating, drinking, smoking or applying cosmetics.

All of the facilities and hygiene practices just discussed are essential to minimize additional sources of lead absorption from inhalation or ingestion of lead that may accumulate on you, your clothes, or your possessions. Strict compliance with these provisions can virtually eliminate several sources of lead exposure that significantly contribute to excessive lead absorption.

VIII. MEDICAL SURVEILLANCE - PARAGRAPH (J)

The medical surveillance program is part of the standard's comprehensive approach to the prevention of lead-related disease. Its purpose is to supplement the main thrust of the standard that is aimed at minimizing airborne concentrations of lead and sources of ingestion. Only medical surveillance can determine if the other provisions of the standard have affectively protected you as an individual. Compliance with the standard's provision will protect most workers from the adverse effects of lead exposure, but may not be satisfactory to protect individual workers (1) who have high body burdens of lead acquired over past years, (2) who have additional uncontrolled sources of non-occupational lead exposure, (3) who exhibit unusual variations in lead absorption rates, or (4) who have specific non-work related medical conditions that could be aggravated by lead exposure (e.g., renal disease, anemia). In addition, control systems may fail, or hygiene and respirator programs may be inadequate. Periodic medical surveillance of individual workers will help detect those failures. Medical surveillance will also be important to protect your reproductive ability-regardless of whether you are a man or woman.

All medical surveillance required by the standard must be performed by or under the supervision of a

licensed physician. The employer must provide required medical surveillance without cost to employees and at a reasonable time and place. The standard's medical surveillance program has two parts-periodic biological monitoring and medical examinations.

Your employer's obligation to offer you medical surveillance is triggered by the results of the air-monitoring program. Medical surveillance must be made available to all employees who are exposed in excess of the action level for more than 30 days a year. The initial phase of the medical surveillance program, that includes blood lead level tests and medical examinations, must be completed for all covered employees no thin this first round of medical surveillance must be given to employees whom the employer believes to be at greatest risk from continued exposure (for example, those with the longest prior exposure to lead, or those with the highest current exposure). Thereafter, the employer must periodically make medical surveillance-both biological monitoring and medical examinations-available to all covered employees.

Biological monitoring under the standard consists of blood lead level (PbB) and zinc protoporphyrin tests at least every 6 months after the initial PbB test. A zinc protoporphyrin (ZPP) test is a very useful blood test that measures an effect of lead on your body. Thus biological monitoring under the standard is currently limited to PbB testing. If a worker's PbB exceeds 40 µg/100g the monitoring frequency must be increased from every 6 months to at least every 2 months and not reduced until two consecutive PbBs indicate a blood lead level below 40 µg/100g. Each time your PbB is determined to be over 40 µg/100g, your employer must notify you of this in writing within five working days of his receipt of the test results. The employer must also inform you that the standard requires temporary medical removal with economic protection when your PbB exceeds certain criteria. (See Discussion of Medical Removal Protection-Paragraph (k).) During the first year of the standard, this removal criterion is 80 µg/100g. Anytime your PbB exceeds 80 µg/100g your employer must make available to you a prompt follow-up PbB test to ascertain your PbB. If the two tests both exceed 80 µg/100g and you are temporarily removed, then your employer must make successive PbB tests available to you on a monthly basis during the period of your removal.

Medical examinations beyond the initial one must be made available on an annual basis if your blood lead level exceeds 40 µg/100g at any time during the preceding year. The initial examination will provide information to establish a baseline to that subsequent data can be compared. An initial medical examination must also be made available (prior to assignment) for each employee being assigned for the first time to an area where the airborne concentration of lead equals or exceeds the action level. In addition, a medical examination or consultation must be made available as soon as possible if you notify your employer that you are experiencing signs or symptoms commonly associated with lead poisoning or that you have difficulty breathing while wearing a respirator or during a respirator fit test. You must also be provided a medical examination or consultation if you notify your employer that you desire medical advice concerning the effects of current or past exposure to lead on your ability to procreate a healthy child.

Finally, appropriate follow-up medical examinations or consultations may also be provided for employees who have been temporarily removed from exposure under standard. (See Part IX, below.)

The standard specifies the minimum content of pre-assignment and annual medical examinations. The content of other types of medical examinations and consultations is left up to the sound discretion of the examining physician. Pre-assignment and annual medical examinations must include (1) a detailed work history and medical history, (2) a thorough physical examination, and (3) a series of laboratory tests designed to check your blood chemistry and your kidney function. In addition, at any time upon your request, a laboratory evaluation of male fertility will be made (microscopic examination of a sperm sample), or a pregnancy test will be given.

The standard does not require that you participate in any of the medical procedures, tests, etc. that your employer is required to make available to you. Medical surveillance can, however, play a very important role in protecting your health. You are strongly encouraged, therefore, to participate in a meaningful fashion. The standard contains a multiple physician review mechanism that would give you a chance to have a physician of your choice directly participate in the medical surveillance program. If you were dissatisfied with an examination by a physician chosen by your employer, you could select a second physician to conduct an independent analysis. The two doctors would attempt to resolve any differences of opinion, and select a third physician to resolve any firm dispute. Generally your employer will choose the physician who conducts medical surveillance under the lead standard-unless you and your employer can agree on the choice of a physician or physicians. Some companies and unions have agreed in

advance, for example, to use certain independent medical laboratories or panels of physicians. Any of these arrangements are acceptable so long as required medical surveillance is made available to workers.

The standard requires your employer to provide certain information to a physician. This information includes (1) the standard and its appendices, (2) a description of your duties as they relate to lead exposure, (3) your exposure level, (4) a description of personal protective equipment you wear, (5) prior blood lead level results, and (6) prior written medical opinions concerning you that the employer has. After a medical examination or consultation the physician must prepare a written report that must contain (1) the physician's opinion as to whether you have any medical condition that places you at increased risk of material impairment to health from exposure to lead, (2) any recommended special protective measures to be provided to you, (3) any blood lead level determinations, and (4) any recommended limitation on your use of respirators. This last element must include a determination of whether you can wear a powered air-purifying respirator (PAPR) if you are found unable to wear a negative pressure respirator.

The medical surveillance program of the lead standard may at some point in time serve to notify certain workers that they have acquired a disease or other adverse medical condition as a result of occupational lead exposure. If this is true, these workers might have legal rights to compensation from public agencies, their employers, firms that supply hazardous products to their employers, or other persons. Some states have laws, including worker compensation laws that disallow a worker who learns of a job-related health impairment to sue, unless the worker sues within a short period of time after learning of the impairment. (This period of time may be a matter of months or years.) An attorney can be consulted about these possibilities. It should be stressed that OSHA is in no way trying to either encourage or discourage claims or lawsuits. However, since results of the standard's medical surveillance program can significantly affect the legal remedies of a worker who has acquired a job-related disease or impairment, it is proper for OSHA to make medical surveillance section of the standard also contains provisions dealing with chelation. Chelation is the use of certain drugs (administered in pill form or injected into the body) to reduce the amount of lead absorbed in body tissues. Experience accumulated by the medical and scientific communities has largely confirmed the effectiveness of this type of therapy for the treatment of very severe lead poisoning. On the other hand, it has also been established that there can be a long list of extremely harmful side effects associated with the use of chelating agents. The medical community has balanced the advantages and disadvantages resulting from the use of chelating agents in various circumstances and has established when the use of these agents is acceptable. The standard includes these accepted limitations due to a history of abuse of chelation therapy by some lead companies. The most widely used chelating agents are calcium disodium EDTA, (Ca Na₂ EDTA), Calcium Disodium Versenate (Versenate), and d-penicillamine (pencillamine or Cupramine).

The standard prohibits "prophylactic chelation" of any employee by any person the employer retains, supervises or controls. "Prophylactic chelation" is the routine use of chelating or similarly acting drugs to prevent elevated blood levels in workers who are occupationally exposed to lead, or the use of these drugs to routinely lower blood lead levels to predesignated concentrations believed to be 'safe'. It should be emphasized that where an employer takes a worker who has no symptoms of lead poisoning and has chelation carried out by a physician (either inside or outside of a hospital) solely to reduce the worker's blood lead level that will generally be considered prophylactic chelation. The use of a hospital and a physician does not mean that prophylactic chelation is not being performed. Routine chelation to prevent increased or reduce current blood lead levels is unacceptable whatever the setting.

The standard diagnostic" chelation if administered under the supervision of a licensed physician in a clinical setting with thorough and appropriate medical monitoring. Therapeutic chelation responds to severe lead poisoning where there are marked symptoms. Diagnostic chelation involved giving a patient a dose of the drug then collecting all urine excreted for some period of time as an aid to the diagnosis of lead poisoning.

In cases where the examining physician determines that chelation is appropriate, you must be notified in writing of this fact before such treatment. This will inform you of a potentially harmful treatment, and allow you to obtain a second opinion.

IX. MEDICAL REMOVAL PROTECTION - PARAGRAPH (K)

Excessive lead absorption subjects you to increased risk of disease. Medical removal protection (MRP) is a means of protecting you when, for whatever reasons, other methods, such as engineering controls, work practices, and respirators, have failed to provide the protection you need. MRP involves

the temporary removal of a worker from his or her regular job to a place of significantly lower exposure without any loss of earnings, seniority, or other employment rights or benefits. The purpose of this program is to cease further lead absorption and allow your body to naturally excrete lead that has previously been absorbed. Temporary medical removal can result from an elevated blood lead level, or a medical opinion. Up to 18 months of protection is provided as a result of either form of removal. The vast majority of removed workers, however, will return to their former jobs long before this eighteen-month period expires. The standard contains special provisions to deal with the extraordinary but possible case where a long-term worker's blood lead level does not adequately decline during eighteen months of removal.

During the first year of the standard, if your blood-lead level is 80 $\mu\text{g}/100\text{g}$ or above you must be removed from any exposure where your air lead level without a respirator would be 100 $\mu\text{g}/\text{m}^3$ or above. If you are removed from your normal job you may not be returned until your blood lead level declines to at least 60 $\mu\text{g}/100\text{g}$. These criteria for removal and return will change according to the following schedule:

	Removal blood lead ($\mu\text{g}/100\text{ g}$)	Air lead ($\mu\text{g}/\text{m}^3$)	Return blood lead ($\mu\text{g}/100\text{ g}$)
After Mar. 1, 1980.....	70 and above.....	50 and above..	At or below 50.
After Mar. 1, 1981.....	60 and above.....	30 and above..	At or below 40.
After Mar. 1, 1983.....	50 and above averaged over six months.	30 and above..	Do.

You may also be removed from exposure even if your blood lead levels are below these criteria if a final medical determination indicates that you temporarily need reduced lead exposure for medical reasons. If the physician who is implementing your employers medical program makes a final written opinion recommending your removal or other special protective measures, your employer must implement the physician's recommendation. If you are removed in this manner, you may only be returned when the doctor indicates that it is safe for you to do so.

The standard does not give specific instructions dealing with what an employer must do with a removed worker. Your job assignment upon removal is a matter for you, your employer and your union (if any) to work out consistent with existing procedures for job assignments. Each removal must be accomplished in a manner consistent with existing collective bargaining relationships. Your employer is given broad discretion to implement temporary removals so long as no attempt is made to override existing agreements. Similarly, a removed worker is provided no right to veto an employer's choice that satisfies the standard.

In most cases, employers will likely transfer removed employees to other jobs with sufficiently low lead exposure. Alternatively, a worker's hours may be reduced so that the time weighted average exposure is reduced, or he or she may be temporarily laid off if no other alternative is feasible. In all of these situation, MRP benefits must be provided during the period of removal -i.e., you continue to receive the same earnings, seniority, and other rights and benefits you would have had if you had not been base wage; it includes overtime, shift differentials, incentives, and other compensation you would have earned if you had not been removed. During the period of removal you must also be provided with appropriate follow-up medical surveillance. If you were removed because your blood lead level was too high, you must be provided with a monthly blood test. If a medical opinion caused your removal, you must be provided medical tests or examinations that the doctor believes to be appropriate. If you do not participate in this follow up medical surveillance, you may lose your eligibility for MRP benefits.

When you are medically eligible to return to your former job, your employer must return you to your "former job status." This means that you are entitled to the position, wages, benefits, etc., you would have had if you had not been removed. If you would still be in your old job if no removal had occurred that is where you go back. If not, you are returned consistent with whatever job assignment discretion your employer would have had if no removal had occurred. MRP only seeks to maintain your rights, not expand them or diminish them.

If you are removed under MRP and you are also eligible for worker compensation or other compensation for lost wages, your employer's MRP benefits obligation is reduced by the amount that you actually receive from these other sources. This is also true if you obtain other employment during the time you are laid off with MRP benefits.

The standard also covers situations where an employer voluntarily removes a worker from exposure to lead due to the effects of lead on the employee's medical condition, even though the standard does not

require removal. In these situations MRP benefits must still be provided as though the standard required removal. Finally, it is important to note that in all cases where removal is required, respirators cannot be used as a substitute. Respirators may be used before removal becomes necessary, but not as an sure job, or to a lay-off with MRP benefits.

X. EMPLOYEE INFORMATION AND TRAINING - PARAGRAPH (1)

Your employer is required to provide an information and training program for all employees exposed to lead above the action level or who may suffer skin or eye irritation from lead. This program must inform these employees of the specific hazards associated with their work environment, protective measures that can be taken, the danger of lead to their bodies (including their reproductive systems), and their rights under the standard. In addition your employer must make readily available to all employees, including those exposed below the action level, a copy of the standard and its appendices and must distribute to all employees any materials provided to the employer by the Occupational Safety and Health Administration (OSHA).

Your employer is required to complete this training program for all employees by August 28, 1979. After this date, all new employees must be trained prior to initial assignment to areas where there is a possibility of exposure over the action level.

This training program must also be provided at least annually thereafter.

XI. SIGNS - PARAGRAPH (M)

The standard requires that the following warning sign be posted in work areas where the exposure to lead exceeds the PEL:

WARNING
LEAD WORK AREA
NO SMOKING OR EATING

XII. RECORDKEEPING - PARAGRAPH (N)

Your employer is required to keep all records of exposure monitoring for airborne lead. These records must include the name and job classification of employees measured, details of the sampling and analytic techniques, the results of this sampling, and the type of respiratory protection being worn by the person sampled. Your employer is also required to keep all records of biological monitoring and medical examination results. These must include the names of the employees, the physician's written opinion, and a copy of the results of the examination. All of the above kinds of records must be kept for 40 years, or for at least 20 years after your termination of employment, whichever is longer.

Record keeping is also required if you are temporarily removed from your job under the medical removal protection program. This record must include your name and social security number, the date of your removal and return, how the removal was or is being accomplished, and whether or not the reason for the removal was an elevated blood lead level. Your employer is required to keep each medical removal record only for as long as the duration of an employee's employment.

The standard requires that if you request to see or copy environmental monitoring, blood lead level monitoring, or medical removal records, they must be made available to you or to a representative that you authorize. Your union also has access to these records. Medical records other than PbB's must also be provided upon request to you, to your physician or to any other person whom you may specifically designate. Your union does not have access to your personal medical records unless you authorize their access.

XIII. OBSERVATIONS OF MONITORING - PARAGRAPH (O)

When air monitoring for lead is performed at your workplace as required by this standard, your employer must allow you or someone you designate to act as an observer of the monitoring. Observers

are entitled to an explanation of the measurement procedure, and to record the results obtained. Since results will not normally be available at the time of the monitoring, observers are entitled to record or receive the results of the monitoring when returned by the laboratory. Your employer is required to provide the observer with any personal protective devices required to be worn by employees working in the area that is being monitored. The employer must require the observer to wear all such equipment and to comply with all other applicable safety and health procedures.

XIV. EFFECTIVE DATE - PARAGRAPH (P)

The standard's effective date is March 1, 1979, and employer obligations under the standard begin to come into effect as of that date.

XV. FOR ADDITIONAL INFORMATION

- A. Copies of the Standard and explanatory materials may be obtained by writing or calling the OSHA Docket Office, U.S. Department of Labor, room N2634, 200 Constitution Avenue, N.W., Washington, DC 20210. Telephone: (202) 219-7894.
 1. The standard and summary of the statement of reasons (preamble), Federal Register, Volume 43, pp. 52952-53014, November 14, 1978.
 2. The full statement of reasons (preamble) Federal Register, vol. 43, pp. 54354-54509, November 21, 1978.
 3. Partial Administrative Stay and Corrections to the standard, (44 FR 5446-5448) January 26, 1979.
 4. Notice of the Partial Judicial Stay (44 FR 14554-14555) March 13, 1979.
 5. Corrections to the preamble, Federal Register, vol. 44, pp. 20680-20681, April 6, 1979.
 6. Additional correction to the preamble concerning the construction industry, Federal Register, vol. 44, p. 50338, August 28, 1979.
 7. Appendices to the standard (Appendices A, B, C), Federal Register, Vol. 44, pp. 60980-60995, October 23, 1979.
 8. Corrections to appendices, Federal Register, Vol. 44, 68828, November 30, 1979.
 9. Revision to the standard and an additional appendix (Appendix D), Federal Register, Vol. 47, pp. 51117-51119, November 12, 1982.
 10. Notice of reopening of lead rulemaking for nine remand industry sectors, Federal Register, vol. 53, pp. 11511-11513, April 7, 1988.
 11. Statement of reasons, Federal Register, vol. 54, pp. 29142-29275, July 11, 1989.
 12. Statement of reasons, Federal Register, vol. 55, pp. 3146-3167, January 30, 1990.
 13. Correction to appendix B, Federal Register, vol. 55, pp. 4998-4999, February 13, 1991.
 14. Correction to appendices, Federal Register, vol. 56, p. 24686, May 31, 1991.
- B. Additional information about the standard, its enforcement, and your employer's compliance can be obtained from the nearest OSHA Area Office listed in your telephone directory under United States Government/Department of Labor.

APPENDIX C to §1910.1025- MEDICAL SURVEILLANCE GUIDELINES

INTRODUCTION

The primary purpose of the Occupational Safety and Health Act of 1970 is to assure, so far as possible, safe and healthful working conditions for every workingman and woman. The occupational health standard for inorganic lead¹ was promulgated to protect workers exposed to inorganic lead including metallic lead, all inorganic lead compounds and organic lead soaps.

Under this final standard in effect as of March 1, 1979, occupational exposure to inorganic lead is to be limited to 50 µg/m³ (micrograms per cubic meter) based on an 8 hour time-weighted average (TWA). This level of exposure eventually must be achieved through a combination of engineering, work practice

and other administrative controls. Periods of time ranging from 1 to 10 years are provided for different industries to implement these controls. The schedule, which is based on individual industry considerations, is given in Table 1. Until these controls are in place, respirators must be used to meet the 50- $\mu\text{g}/\text{m}^3$ exposure limit.

The standard also provides for a program of biological monitoring and medical surveillance for all employees exposed to levels of inorganic lead above the action level of 30 $\mu\text{g}/\text{m}^3$ (TWA) for more than 30 days per year.

The purpose of this document is to outline the medical surveillance provisions of the standard for inorganic lead, and to provide further information to the physician regarding the examination and evaluation of workers exposed to inorganic lead.

Section 1 provides a detailed description of the monitoring procedure including the required frequency of blood testing for exposed workers, provisions for medical removal protection (MRP), the recommended right of the employee to a second medical opinion, and notification and record keeping requirements of the employer. A discussion of the requirements for respirator use and respirator monitoring and OSHA's position on prophylactic chelation therapy are also included in this section.

Section 2 discusses the toxic effects and clinical manifestations of lead poisoning and effects of lead intoxication on enzymatic pathways in heme synthesis. The adverse effects on both male and female reproductive capacity and on the fetus are also discussed.

Section 3 outlines the recommended medical evaluation of the worker exposed to inorganic lead including details of the medical history, physical examination, and recommended laboratory tests, that are based on the toxic effects of lead as discussed in Section 2.

Section 4 provides detailed information concerning the laboratory tests available for the monitoring of exposed workers. Included also is a discussion of the relative value of each test and the limitations and precautions that are necessary in the interpretation of the laboratory results.

TABLE 1

Permissible airborne lead levels by industry ($\mu\text{g}/\text{m}^3$) ¹	Effective date					
	Mar. 1, 1979	Mar. 1, 1980	Mar. 1, 1981	Mar. 1, 1982	Mar. 1, 1984	Mar. 1, 1989 (final)
1. Primary lead production	200	200	200	100	100	50
2. Secondary lead production	200	200	200	100	50	50
3. Lead-acid battery manufacturing	200	200	100	100	50	50
4. Nonferrous foundries	200	100	100	100	50	50
5. Lead pigment manufacturing	200	200	200	100	50	50
6. All other industries	200	50	50	50	50	50

¹Airborne levels to be achieved without reliance on respirator protection through a combination of engineering, work practice and other administrative controls. While these controls are being implemented respirators must be used to meet the 50- $\mu\text{g}/\text{m}^3$ exposure limit.

I. MEDICAL SURVEILLANCE AND MONITORING REQUIREMENTS FOR WORKERS EXPOSED TO INORGANIC LEAD

Under the occupational health standard for inorganic lead, a program of biological monitoring and medical surveillance is to be made available to all employees exposed to lead above the action level of

30 µg/m³ TWA for more than 30 days each year. This program consists of periodic blood sampling and medical evaluation to be performed on a schedule that is defined by previous laboratory results, worker complaints or concerns, and the clinical assessment of the examining physician.

Under this program, the blood lead level of all employees who are exposed to lead above the action level of 30 µg/m³ is to be determined at least every six months. The frequency is increased to every two months for employees whose last blood lead level was between 40-µg/100 g whole blood and the level requiring employee medical removal to be discussed below. For employees who are removed from exposure to lead due to an elevated blood lead, a new blood lead level must be measured monthly. A zinc protoporphyrin (ZPP) measurement is required on each occasion that a blood lead level measurement is made.

An annual medical examination and consultation performed under the guidelines discussed in Section 3 is to be made available to each employee for whom a blood test conducted at any time during the preceding 12 months indicated a blood lead level at or above 40 µg/100 g. Also, an examination is to be given to all employees prior to their assignment to an area in that airborne lead concentrations reach or exceed the action level. In addition, a medical examination must be provided as soon as possible after notification by an employee that the employee has developed signs or symptoms commonly associated with lead intoxication, that the employee desires medical advice regarding lead exposure and the ability to procreate a healthy child, or that the employee has demonstrated difficulty in breathing during a respirator fitting test or during respirator use. An examination is also to be made available to each employee removed from exposure to lead due to a risk of sustaining material impairment to health, or otherwise limited or specially protected pursuant to medical recommendations.

Results of biological monitoring or the recommendations of an examining physician may necessitate removal of an employee from further lead exposure pursuant to the standard's medical removal protection (MRP) program. The object of the MRP program is to provide temporary medical removal to workers either with substantially elevated blood lead levels or otherwise at risk of sustaining material health impairment from continued substantial exposure to lead. The following guidelines that are summarized in Table 2 were created under the standard for the temporary removal of an exposed employee and his or her subsequent return to work in an exposure area.